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THE INFLUENCE OF GROWTH ON CONGENITAL AND ACQUIRED DEFORMITIES

By

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This Book is Dedicated

TO MY BROTHER,

THE REV. DR. EDWARD JUDSON,

IN AFFECTIONATE
APPRECIATION OF HIS GOOD WORDS AND
BENEFICENT DEEDS.

PREFACE.

THE original intention of writing a paper which should call attention to the influence of growth has led to the preparation of this book. Certain features have been included which, although not entirely novel in themselves, are yet presented in a new light which gives them importance as matters that will repay close attention in practice. Among the subjects thus treated are: the application of the weight of the body for the reduction of club-foot, the use of the equine position of the foot to increase the length of a shortened limb, the adoption of symmetrical movements and correct rhythm for removing deformity and excluding lameness, and the manner in which misleading tumors are produced by the rotation of lateral curvature. It is difficult to overlook entirely the element of growth when patients are with few exceptions children, and in view of the fact that the word orthopædic is derived from two Greek words carrying the ideas of straightness and juvenile development.

A. B. JUDSON.

NEW YORK, January, 1905.

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THE INFLUENCE OF GROWTH

UPON

Congenital and Acquired Deformities.

INTRODUCTION.

I VENTURE to present to the reader a new volume on orthopædic subjects, not because there is any lack of excellent systems and text-books, but rather to emphasize what seems to lie at the base of practice in this specialty, the fact that prevention and cure are to be found in so managing a case and equipping a patient that natural growth will be the principal factor in recovery. Mr. Hilton said: "Repair is but the repetition of growth. The same elements, the same kindred conditions are necessary to the same results." This view is far from including all there is in orthopædic practice, but the thought thus expressed should temper the consideration of all procedures, whether operative or mechanical, which have for their object the removal of deformity.

The average length of a new-born baby is nineteen and a half or twenty inches. During the first six

months he grows from four to five inches, and in the second six months from three to four inches. During the second year he grows from three to five inches; during the third year from two to three inches and a half; and during the fourth year from two to three inches. By the end of the fifth year the child has generally doubled his original length. After that his average annual growth is from one inch and two-thirds to two inches, with a slight acceleration in the years just preceding puberty. This period of gradual increase in size, covering nearly a quarter of the three score years and ten, may not be neglected in intelligent efforts to banish deformity and promote physical ability, refreshing the significance of Andry's designation of orthopædic surgery as the "art of making a child grow straight." If the surmise is correct that the rate of growth is not uniform from year to year, but is now rapid and again slow, it would be well if fluctuations in the rate could be recognized or foreseen, making possible especial orthopædic efforts when growth is rapid and comparative relaxation of treatment when it is progressing more slowly.

The methods of diagnosis, prevention, and treatment herein presented are put on record as having proved useful and as likely to be at least suggestive in the practice of others. These pages probably contain very little that is new or presented for the

first time. So-called new observations and inventions in medicine and surgery have generally been made before and recorded on some page which for some reason or other has not been read. In regard to "new truths," it has been wittily said that "what is true is not new and what is new is not true." In all departments of industry improvements are planned some time before they are realized or tested, because unfavorable conditions have to be first changed by improvements in other departments. Imagination walks ever in front of the advancing line of the arts and sciences, and no member of the band may progress except in company with the rest. In orthopædic surgery methods have improved, not because something new has been learned about disease and principles of treatment, but rather because general knowledge has increased and difficult mechanical effects have become convenient through improvements in and novel applications of such materials as adhesive plaster, gypsum, and steel. The fine adjustments which Fayette Taylor made by ingeniously constructed joints in his "spinal assistant" are now more readily made in Bessemer steel. Conditions of advance are not only physical, but are also found in mental attitudes which are liable to change in response to reason and experience. When the fear of wounding a tendon was overcome, subcutaneous tenotomy was accepted. The fear of ankylosis may

in course of time subside, and the views of the surgical world may in due order turn in favor of intelligent expectation in the management of joint diseases, thus making good Mr. Hilton's additional words: "Rest is the necessary antecedent to the accomplishment of repair and growth. This is surely the natural suggestion of a means toward an end which should never be lost sight of by the physician or surgeon."

CHAPTER I.

CONGENITAL CLUB-FOOT.

THE effect of natural growth on deformity is very evident in a case of congenital club-foot. A baby gains in length from seven to nine inches in the first year, in which period the deformity becomes more obvious and obstinate with each added month; but if the foot is held in a good position, growth introduces symmetry and facilitates restoration.

TREATMENT AT AN EARLY STAGE.

This deformity cannot receive attention too early. Dr. Willard says: "The time for beginning the treatment of congenital club-foot is at the hour of birth." The limb should at once begin to grow straight instead of growing crooked. Ready to yield, the little foot seems to be held out in an appeal for the application of a lever, making points of pressure and counter-pressure in the directions indicated by the arrows in Figs. 1, 2, 3, and 4. A plaster-of-Paris dressing observes the same points of action. The brace shown in Figs. 3 and 4 may be made of brass or other convenient metal. The thin discs are softly

padded. The brace is applied with three strips of adhesive plaster and very gradually bent to different shapes, as seen in Figs. 5, 6, 7, and 8, the foot taking on corresponding shapes until it occupies the concavity of the brace where valgus is seen instead

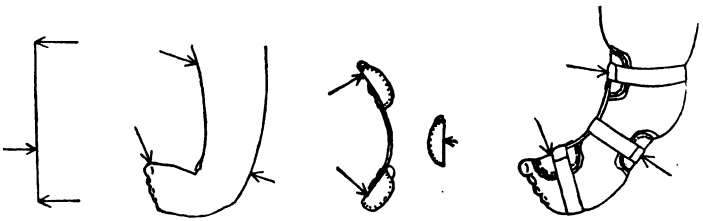


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

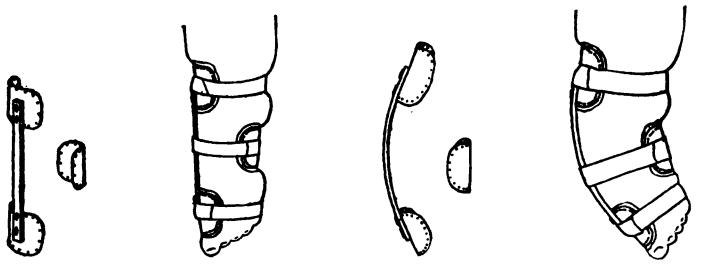


FIG. 5. FIG. 6. FIG. 7. FIG. 8.

FIGS. 1–8.—Points of Pressure and Counter-pressure in the Early Stage of Treatment, and Changes made in the Brace and in the Shape of the Foot.

of varus. These successive changes took place and were carried farther in Case I., as is shown in Fig. 22, on page 22. Correction cannot well be overdone in this stage. The details of this application are presented more clearly in Fig. 9, which shows the right foot of a boy six months old in process of correction.

The plaster surrounding the leg and the upper shield and that surrounding the foot and the lower shield are lightly applied as they simply hold the apparatus in place. The middle plaster, after being securely fastened by several turns around the upright, receives the unattached middle shield and surrounds the lower part of the leg and the brace. While one hand reduces deformity by forcing the limb and brace together, let the other hand secure the middle plaster after repeatedly carrying it around the limb and the upright of the brace, being ever mindful of the pressure made by the middle shield, which is the key to the application. It is needless to say that careful attention is required to secure comfort and efficiency, which follow the skill born of repetition. Under advice and instruction the successful carrying out of the necessary details depends on the intelligence found in the patient's home. Reduction is assisted by the position of the babe "in arms,"



FIG. 9.—Details of Application.

where no part of his weight interferes with the mechanical force used. One or two days in each week may be given to freedom of the foot and manipulation in order to maintain flexibility. Without haste, violence, or pain, the foot, having doubled its size by growth, will be found valgus when resting undisturbed, and the tendo Achillis, as an incidental effect and without especial attention, will be sufficiently lengthened to permit a right-angled position of the foot. This, the first stage of treatment, should be concluded long before walking begins.

Early Use of Adhesive Plaster.—In the case of a new-born babe, before a brace can be prepared, the trouble may be met by surrounding the foot with a strip of adhesive plaster in such a manner as partly to correct deformity, the improved position being secured by making firm traction on the long end of the plaster and attaching it to the outer side of the leg. This method was advocated in 1850 by Dr. S. D. Gross, at that time one of the faculty of the New York University. The same material had, however, been used, although in a different way, many years before in the treatment of this affection. In 1740 Mr. Cheselden wrote: "The first knowledge I had of a cure of this disease was from a professed bone-setter. I recommended the patient to him, not knowing how to cure him myself. His way was by holding the foot as near the natural position as he

could and then rolling it up with strips of sticking plaster, which he repeated from time to time as he saw occasion, until the limb was restored to a normal position." In orthopædic practice the material or method is often of less importance than the skill and enthusiasm of the physician. If he has invented or improved an instrument, the attendants of the patient, inspired by his confidence, unite with him in overcoming the inconvenience and trouble inseparable from mechanical treatment and thus succeed where others meet with disappointment.

TREATMENT AT A LATER STAGE.

When the patient, with his foot now in good shape, learns to walk a critical stage of treatment begins. If left to itself the foot will relapse at once under the weight of the body, which develops a distinct boundary plane dividing varus from valgus as the foot presses the ground. By way of illustration, place the ulnar border of the hand on a table and it will be seen that pressure, with alternations of pronation and supination, will in turn produce full pronation, corresponding with valgus in the foot, and full supination, corresponding with varus. Applying pressure equal to twenty-five pounds brings to light the fact that the weight of a child will, if properly directed, insure a normal foot, or if misdirected confirm de-

formity. Advantage of this may be taken by the use of a brace that holds the foot, even a little, on the right side of the plane between varus and valgus.



FIG. 10.— Flexible Paralytic Club-foot of the Patient seen in Fig. 17 (p. 14).



FIG. 11.—Brace for Foot shown in Fig. 10.

The child may thus, with increasing weight and activity, achieve recovery by **stamping the foot straight.** Fig. 10 shows the deformed but flexible foot of a child four years old. The brace used in this case is shown in Fig. 11. Its weight is thirteen ounces. It is made of soft steel and has a band, an upright, and

a foot-piece composed of a tread and a riser. The foot-piece is lined with adhesive plaster to prevent rust and a piece of truss leather fastened with two copper rivets. More or less valgous in shape, the instrument makes pressure on the outer side of the ankle, while counter-pressure on the inner side is found at the upper part of the brace and along the riser of the foot-piece. The sole of the foot finds on the tread an inclined surface like that of the inner side of the sole of a shoe whose outer border has been thickened in order to precipitate valgus, an effect which is seen in Fig. 12. This favors the leverage by which the foot is held on the right side of the plane.

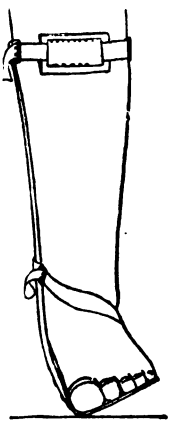


FIG. 12. — Tread of Brace with the effect of a Built-up Sole (1892).

Dr. Cook ingeniously sought to combat varus by providing the sole of a common shoe with an ample steel extension directed outward in order to reduce deformity with the descent of the body, in imitation of the method by which quadrupedal gait is modified by the application of a horseshoe forged with a lateral or antero-posterior extension. His experience proved that such an application would probably be more effective in club-foot if a coalition were practicable between the foot and shoe, such as is found in veterinary practice.

The upright of the brace may be inclined backward ten or fifteen degrees with a corresponding extension of the foot. This increases the length of the lever applied against deformity. Thus arranged, the tread will cut the sole of the shoe, which may be protected by a steel in-sole (about an inch wide) lying between the brace and the shoe, or else cut to fit the anterior part of the sole and fastened inside the shoe by a screw. The strap which spans the front of the leg carries a sliding pad to allay the friction transferred to this point from the toe, as in the treatment of talipes calcaneus (p. 47). This arrangement is otherwise useful in relieving the front part of the foot from part of the weight of the body, which seriously interferes with the correction of deformity. It also seems to have an entirely unexpected tendency to lengthen the heel cord.

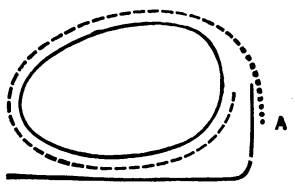


FIG. 13.—Adhesive Strip Applied to Untwist Anterior Part of Foot (1887).

The action of the brace may be improved by the use of adhesive plaster applied as in Fig. 13, a strip encircling the foot and buckled to the riser at *A*; or a window, *D*, may be cut in the junction of the tread and riser, as seen in Fig. 14, through which the plaster *C*, passes to the buckle *F*, on the under side of the tread. The plaster may be conveniently doubled, as at *A* in Fig. 15, the remainder of the facing, *B*,

being removed at the time of application. The prehension and traction made by this material admirably imitate the action of the hand, making pressure

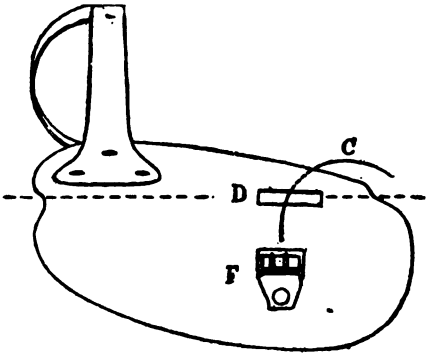


FIG. 14.—Window for Exit of Adhesive Strip (1896).

in the selected directions, untwisting the anterior part of the foot and keeping the toes from surmounting the riser.

Fig. 16 shows the brace applied to the foot, and Fig. 17 the child equipped for stamping her foot straight, increasing activity and weight and juvenile growth combining to secure a good result. Applied

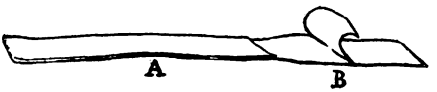


FIG. 15.—Adhesive Strip Ready for Application.

under or over the stocking, the brace is worn inconspicuously and without inconvenience for many months, a larger one being made when required by

the patient's growth, which being rapid at this age is a welcome ally. By the end of the fifth year a child has doubled his original length, an increment that has perforce a positive effect for benefit or injury.



FIG. 16 —Brace seen in Fig. 11, Applied to Foot seen in Fig. 10.



FIG. 17.—Brace Applied and Foot Dressed.

Nothing especial is needed in the way of shoes, the mate of the other shoe answering every purpose. If necessary the capacity of the shoe may be increased by cutting it down in front and adding more eyelet holes. With this instrument treatment may be concluded. The result should be normal ability, prac-

tically not impaired by a heel cord somewhat shorter than normal. This tendon with the other fibrous structures would doubtless yield to direct mechanical treatment, but it is found to adapt its length to the requirements of walking and running without especial attention in the course of treatment.

Inversion, commonly seen at an early stage, may not cause anxiety as it takes place at the hip, and disappears under instruction when the child learns, in due time, the necessity of making a good appearance. Parental impatience sometimes leads to cessation of treatment after the brace has been worn for several months with apparently full recovery; but when a relapse to varus is indicated by the reappearance of a callus and the rapid wearing through of the outer border of the sole of the shoe, treatment is necessarily resumed for another period. Success implies perhaps uncommon intelligence in the parents, who should possess the difficult quality of patience and be able to give appreciative attention to the case at home. On the other hand the surgeon has no easy task who makes the frequent necessary mechanical adjustments and cannot escape ultimate responsibility for the home management.

The Club-foot of Spastic Contraction.—Correction of deformity by the weight of the body properly directed is illustrated in the equino-varus seen in a case

of spastic contraction. The muscles being readily overcome by continuous leverage, the corporal weight holds the foot in the normal position, which continues when the brace is laid aside after a period of treatment in which growth has made some progress. A patient thus aided to walk enjoys a general improvement which seems to react favorably on the nervous disorder.

NEGLECTED, RELAPSED, AND INVETERATE CLUB-FOOT.

While it is thus easy to remedy congenital club-foot when taken early and treated systematically there is great difficulty in the restoration of neglected, relapsed, or inveterate cases, of either congenital or acquired origin. Operative treatment is necessary in nearly every case of this kind, and judgment will be required lest an improvement in appearance is gained at the expense of locomotor ability, which is good in many cases even of severe deformity. Bradford and Lovett's treatise records the surprising locomotor skill and agility acquired in certain cases in which deformity had gone uncorrected. A moderately severe resistant club-foot is seen in Fig. 18. In such a case the application of a brace which forcibly holds the varus partly corrected gives excellent ability in walking and running, and is

often and very excusably preferred by the youthful patient to an operation which would lessen the strength and ability of the foot, although improving its appearance. Worn in this way the brace is a purely prosthetic appliance. Its effect would, however, be therapeutic and ultimately curative if the patient could be induced to relieve the foot from the weight of the body by wearing in addition a pair of crutches or an ischiatic support for the time necessary to bring the foot around to that position in which the weight of the body would assist in completing the reduction of the deformity. It is of course far better to foresee these troubles in the very early youth of the patient when complete restoration is easily practicable.



FIG. 18.—Resistant Paralytic Club-foot, Age Ten Years.

Double Club-foot.—The recumbent position is necessary if the affection is double, unless one limb be treated at a time, in which case—as when only one foot is affected—resort may be had to crutches, or, better, to ischiatic support, with a high sole under the other foot, as in hip or knee disease, until the straightening of the brace and the foot and continuous leverage lead the way to the vantage-ground where the weight of the body may be enlisted as a corrective force.

Subcutaneous Tenotomy.—If the tendo Achillis fails to meet the requirements of locomotion after reduction of deformity by this method, as a last re-



FIG. 19.

maining defect it may be divided. In 1831 Dr. Stromeyer (1804–76) made his first section of this tendon, an operation which has been said to "mark the beginning of the whole system of subcutaneous sur-

gery and of all really successful orthopædic treatment." Five years later Dr. Little (1810–94) visited Stromeyer and against the advice of friendly medi-





FIG. 20.

cal authority submitted to tenotomy for talipes equino-varus (left), following an attack of infantile paralysis at the age of four years. The result in this and other cases "caused a revulsion of feeling in favor of subcutaneous tenotomy," which was first performed in

England by Dr. Little himself in 1837. In that year Dr. Detmold (1808–94), coming to New York, "introduced orthopædic surgery into America," making one hundred and eighty divisions of the heel cord in two



FIG. 21.

years. In current medical opinion Stromeyer is credited with the discovery of subcutaneous tenotomy, Little with having widely disseminated a knowledge of it, and Detmold with its introduction

into this country. Not a few of the advances of surgery have been due to previous misconceptions of the danger of invading certain regions or wounding certain tissues. Stromeyer's discovery greatly encouraged the study and practice of orthopædic surgery. With further advances in general medicine and surgery it is probable that other changes of mental attitude will be seen and other modifications will be accepted in the methods of this branch of practice.

The Goniometer.—The flexion of the foot on the leg may be conveniently measured by the goniometer. With the knee flexed in order to relax the gastrocnemii and the tendo Achillis, and the foot held midway between varus and valgus, one arm of the instrument may be held parallel with the crest of the tibia, and the other with the plantar surfaces of the heel and the ball of the foot. The degrees of flexion may then be read on the scale. After club-foot it is difficult without impairing the power of the limb to give to the heel cord the length which normally permits flexion of fifty or sixty degrees. But flexion of twenty or twenty-five degrees, which is acquired in the course of routine treatment, practically secures full ability without defect of gait.

CASE I.—*Double Congenital Club-foot.*—Without previous attention, treatment was begun September 5th, 1896, at the age of three months, the shape of the boy's feet at that age being seen in Fig. 22, which

also shows the progress made in the case until the child was five years old. The natural increase in size was clearly an important element in correction.

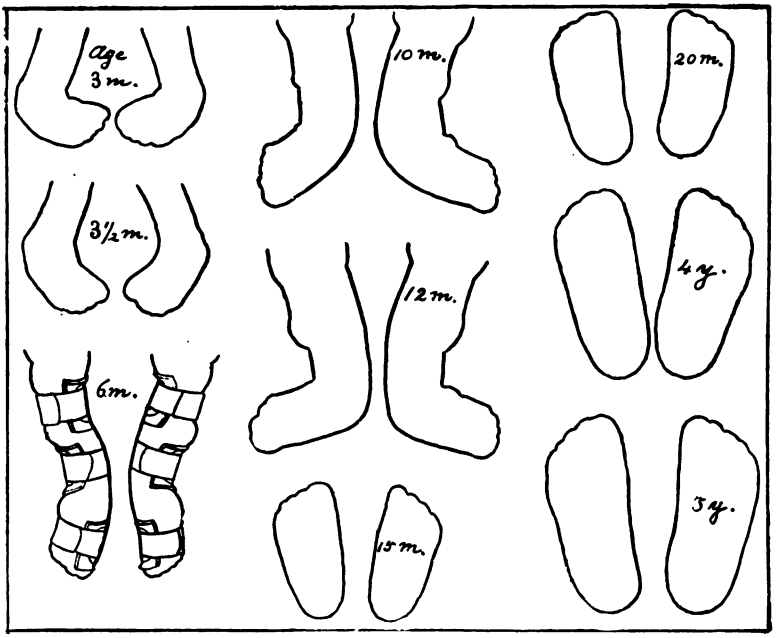


FIG. 22.—Case I. Reduction Begun by Leverage, Promoted by the Favorable Action of the Weight of Body, and Aided by Growth.

The outlines were grouped and reduced *en bloc* in the camera and were thus made to present their relative proportions. The first stage of treatment occupied twelve months, in which forty-three visits were made to the office. The appearance and lateral flexibility being normal, treatment was then sus-

pended. At the end of five months, in which nothing was done, the child had learned to walk, and it was noticed that the outer borders of the soles were becoming callous. Braces were therefore applied like the one seen in Fig. 11, larger ones being substituted as the child grew. In this stage forty-two visits were made in twenty-two months, and treat-



FIG. 23.—Case I., Corrected Double Congenital Club-foot. Age of patient, seven years.

ment finally ceased when the patient was four years old. A year later the last outlines seen in Fig. 22 were taken. At that time the left ankle was flexible

twenty-five degrees, and the right thirty degrees. When walking or running the boy had no defect in his gait. Two years later calluses were absent and



FIG. 24.—Case I., Corrected Double Congenital Club-foot.

the toes were not inverted in walking. The limbs are seen in Figs. 23, 24, and 25. He was doing what other boys of his age do, with no indication that his feet had ever required especial attention.

An operation is often a desirable resort in club-foot. Some visits to the physician may thus be escaped. The statement that to operate for club-foot is a confession of failure is too sweeping. Oper-

ations must, however, be supplemented by mechanical treatment.

A general view of the subject shows that congenital club-foot, being an affection easily responsive to treatment, is as a rule well and promptly corrected by the method and with the instruments and materials most conveniently under the control of the physician responsible for the case. To insure success,



FIG. 25.—Case I.. Standing with Toes Raised.

however, all expectation of a speedy cure should be frankly abandoned at the outset, and preparation made for diligent treatment begun soon after birth

and continued until growth is well advanced. Better results are reached by patiently relying on slow methods and natural growth than by resorting to forcible correction repeated whenever the deformity becomes offensive through neglect. There is, moreover, one source of disappointment which should be borne in mind, and that is the idea that wearing a brace is all that is necessary. A brace in itself is entirely inefficient. It must accomplish a constant definite purpose, which it can be made to do only by the presence and alertness of an intelligent mind. The most faithful and anxious parent requires frequent advice and supervision, not to mention the readjustments and alterations of apparatus repeatedly required with the lapse of time and changes in the foot. In the history of a case thus managed there will be intervals of considerable length, when treatment may be suspended, to be resumed with the first sign of returning deformity.

FLAT-FOOT.

The human foot, for many reasons, does its work at a disadvantage. The corporal weight falls on two, instead of four, pedal extremities, as in some other animals. The delicate and complicated construction of the feet and the small floor area which they occupy seem out of proportion to their duty of support-

ing the towering frame above them, in some cases not unlike a pyramid on its apex. The carrying of such a load is a menace to these overburdened members, and when a prolonged effort is made under additional weight, as by a native carrier in strange lands or an armed soldier on a forced march, the endurance of the feet excites wonder. With the common ailments, such as corns, bunions, chilblains, blisters, ingrowing nails, hammer toes, hallux valgus, Morton's toe, perforating ulcers, weak ankle, loss of the arch, bursitis and osteitis, the foot seems destined for disability soon after the journey of life is begun and certainly when the pilgrim takes on the fat that goes with age and good living. It was a profane remark of Savarin, the great gourmand, that among the works of creation the design of the human foot was a conspicuous failure. It is sufficiently evident to the student that only a consummate adaptation of mechanics has enabled this discredited member to perform its superlative functions. He should therefore undertake its reconstruction only after a good deal of hesitation. The treatment of disabled and deformed feet is indeed beset with difficulty, especially if undertaken while the feet are in use.

One of the common ailments is impairment or loss of the arch, deforming the foot, but less serious as a deformity than as a painful disability. It is caused evidently by overuse or a failure to appreciate until

too late the fact that machinery of this kind has a limit of endurance. The beginning of the trouble is insidious, pain resembling that of rheumatism shifting and visiting different parts of the foot and leg, and accompanied by a gradual depression of the arch, one foot preceding the other on the downward road. Periods of rest are followed by relief from pain, but a return to work recalls the trouble. After a few months or years of misery the feet become truly flat and are useful and painless for the rest of life, the related and coordinating structures having gradually become adapted to each other and to the abnormal state of affairs. Waiters, chambermaids, and salesmen become footsore from too much standing and walking. In hospitals it is a common affection among nurses who have not before been much on their feet. Rapid growth and a sudden increase in flesh are contributing causes. The trouble attacks bartenders whose hours are long and who wear thick soles on beer-soaked floors, and it is said to be common in boys who follow the plough through soft soil in heavy boots.

Direct reinforcement of the arch by an upward curving in-sole is naturally the first suggestion in the way of treatment. This requires, however, very skilful and exact adjustment, since a great and active burden must be supported by a comparatively slight substructure. Many cases will probably be better

managed indirectly, as by a change to some occupation requiring less work from the feet. As this is seldom convenient, relief may be sought by taking advantage of heretofore neglected opportunities to sit, avoiding unnecessary walking in the intervals of work, and by other means of sparing the feet which will occur to the mind with an acquired knowledge of the threatening peril. An interesting observation is that when a patient's attention is called to the point he finds it easier to walk up a moderately inclined path than down, showing that a desirable position is that of flexion of the foot on the leg, which may be promoted by lessening or removing the heel of the shoe. In other ways also the shoes may be improved. The sole should be very flexible and the ankles left free from constriction. A common method of strengthening the foot by tightly lacing the shoe around and above the ankle should be omitted as a vain attempt to support impending weight by inadequate means.

Shoes made especially for the support of the ankle are useless in any case, and especially for the feet of a growing child. It is better to avoid undue fatigue and to look for natural development of strength and stability by moderate exercise of the feet and ankles unsupported. Constriction of the ankle cannot but impair the efficiency of the muscles of the leg, which control the multiform motions of the foot through a

complex system of tendons, the direction of which is changed by turning the corner of the ankle. When restraints are removed from the ankle, and especially when shoes, large and comfortable in other respects, are prescribed for flat-feet, the first result will probably be an increase of pain in locomotion, which should be expected after a sudden change of this kind. If the first pain and inconvenience are endured they cease after a time and give way to unexpected comfort and surprising ability in walking. The patient has been doing the wrong thing for a long time, and may not expect a sudden and painless return to the path of rectitude. He may be exhorted in the words of Dr. Fayette Taylor, who was wont to say that one could not go up hill any quicker than he went down.

Locomotion in a painful stage is facilitated by transferring weight from the toe to the heel. This is inferred from the fact that comfort comes with removal of the heel from the shoe, which produces flexion of the foot on the leg, an attitude in which the heel is thrust down toward, and the toe withdrawn upward from, the ground. It is well, therefore, to relieve pain by leaning a little backward in standing and walking, which moves a part of the weight from the arch to the heel. It may not be possible in many cases to restore the lost arch, but by a resort to timely rest and minor devices, commonplace but

effective, comfort and ability in walking may be assured.

Minor Afflictions of the Feet.—Flat-foot is an ailment for which there is really no good excuse. For the results of joint disease, or of infantile paralysis, the patient may not justly be held accountable, but with prudence and intelligence he should escape breaking down or wearing out of the feet. He should also be held to account for other common ailments such as ingrowing nails, hammer toes, hallux valgus, and corns.

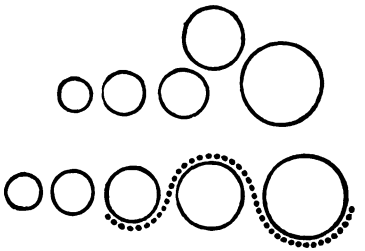


FIG. 26.—Alignment of Toes Enforced by Adhesive Plaster (1887).

The latter affliction may be eliminated by maceration at *stated intervals*, in a tepid saponic solution, and removal of extraneous epidermis by erasion. If this domestic procedure is repeated *only* when pain becomes intolerable, the trouble will recur interminably through moderate pressure concentrated on underlying bony processes.

Hammer toes result from overcrowding the digits in tight shoes. This ill may be relieved by amputation of the rampant toe through its metatarsal bone, an operation sometimes practised, it is said, on the second digit of a normal foot in the search for cos-

metic effects. Reduction may be assisted by the application of a narrow piece of plaster, as in Fig. 26, which readily corrects overlapping during the time of growth.

Ingrowing nails are caused by thoughtless rupture of a *modus vivendi*, in which the nail preempts a nidus, and the callous skin, as the result of long custom, tolerates the lateral edges and corners of the nail, which should never be retrenched except by a "bang" stroke, made at right angles with the axis of the phalanx. Relief in the worst cases surely follows the necessarily slow restoration of the *modus vivendi* referred to.

CHAPTER II.

DEFORMITIES AND DISABILITIES CAUSED BY INFANTILE PARALYSIS.

WHEN the eighteen months (which are said to be the limit of spontaneous recovery from anterior poliomyelitis) have passed, the affected muscles are found to be paralyzed at a critical time in the child's history, when the development of the joints of the lower limbs is especially rapid under the incitement and exertion of learning to walk. Although walking is a commonplace act and receives but little attention, it is really a difficult feat learned only after long and laborious practice, in which the will commits the machinery of locomotion almost entirely to reflex control.

Comparative Exemption of the Upper Limbs.—It is in the lower extremities that the deformities and disabilities caused by this form of paralysis are conspicuous. They rarely attract attention in the upper limbs. It is not necessary to explain this fact by the supposition that the affection has a preference for the nervous filaments supplying the lower extremity. A probable explanation is offered in the proposition that sufficient power is gained in the upper

extremity and not in the lower, because in the former the muscles can advance from small to great efforts, gaining power gradually by increasing use, while in the latter, where there is failure at the outset to control the weight of the body, the fibres miss the very beginning of development. It has been held that assistance given gradually to muscles thus affected is an incitement to recovery of power. Possibly a postponement of the erect position and a series of graduated exercises enforced through the period of early growth might measurably restore muscular power and avert some of the threatening locomotor disability.

PARALYSIS OF THE ANTERIOR MUSCLES OF THE THIGH.

Occurring as an epidemic in the hot season, infantile paralysis is seldom recognized until the fever subsides and certain groups of muscles are found to have lost their motor innervation. Affecting the muscles of the thigh, it entails a miserable defect in the gait. If the quadriceps extensor is paralyzed the foot cannot be held out by an extension of the knee when the patient is sitting, and in walking he is apt to put a hand on the lower part of the thigh to keep the limb from flexing and causing a fall. If the treatment of such a case is neglected or postponed the child takes a crutch, and when the paralysis is

well marked the whole leg is consigned to disuse and atrophy. The other parts of the limb may be useful and strong, but weakness at this point, like the removal of the keystone from an arch, demolishes the whole structure. Disuse leads to poor circulation, the limb hangs useless against the crutch, it suffers from cold, and in various ways is such an annoyance that in later years amputation is not uncommonly a welcome resort. Sometimes the attenuated thigh and leg are bound together to form a stump for an artificial limb.

Treatment.—The obvious remedy lies in mechanical reinforcement coincident with growth for the purpose of lessening present disability and encouraging local and general functional development, the recompense being future unaided locomotion with the broad coaptated surfaces of a hyperextended joint. The points of pressure and counter-pressure required in such a case are indicated by the arrows in Figs. 27 and 28. A brace applied in the case of a child weighed one pound and two ounces.

Counter-pressure is made at the lower end of the brace by a heel cup formed by webbing riveted to the upright and to the border of the tread, in the manner shown in Fig. 40, p. 48, and this in many cases is the only piece of webbing in the whole apparatus. The upright may occupy the inner or the outer side of the limb, according as the condition of

the foot requires buckles and straps for opposing varus or valgus. Aside from these no attachments are needed, the splint being held in place by the steel

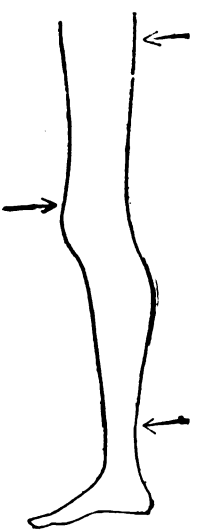


FIG. 27.

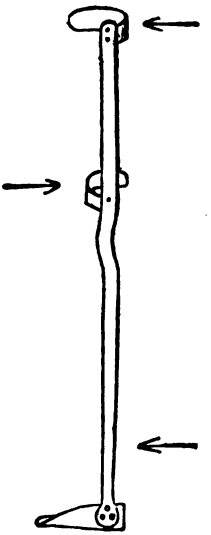


FIG. 28.

FIGS. 27, 28.—Points of Pressure and Counter-pressure in Paralysis of Anterior Muscles of the Thigh (1888).

bands which half encircle the limb; their tractable steel should be so curved that when the splint is looked through endwise the lumen formed by the steel bands should not much exceed the antero-posterior diameter of the shaft of the femur. To prevent rust the steel may be wound with adhesive strips and some convenient renewable fabric. The stocking will intervene between the skin and the

lower part of the brace, the foot-piece being lined as that of a brace for club-foot. The chief pressure falls on two points of the thigh, an upper posterior and a lower anterior point; but pads and wadding, as in all orthopædic apparatus, are better avoided as far as is possible. With a knee stiffened in this way, and a limb perhaps otherwise defective in innervation, walking will be far from graceful. The gait will, however, be strong and effective, and the patient will be gratified by his ability to walk a longer distance and faster than before. In cases of this kind every additional gain in power is highly valued. When sitting becomes inconvenient from increasing length of limb in a growing patient a joint may be introduced at the level of the knee, as in Fig. 29, with automatic fixation, alternating with voluntary release, as shown in Fig. 30. A brace applied in the case of a very heavy patient weighs three pounds and eight ounces. It gives firmness to the gait and an ability to flex the knee at will. Women thus equipped have been enabled to assume the devotional duties of monastic life.



FIG. 29.—Brace with Joint at the Knee.

Two forms of "release" are seen in Figs. 31 and 32, the "bucket" and the "lever." A "fall joint,"



FIG. 30.—Brace Flexed.

in which a tube or hood slides down the upright over the joint is probably more easily made, but in order

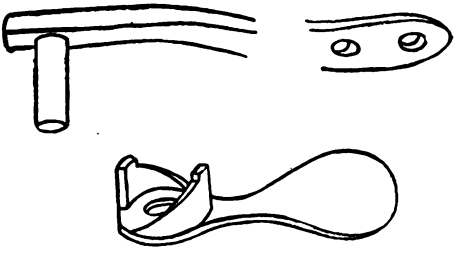


FIG. 31.—Details of "Bucket Release."

to allow the "fall" to be raised far enough to clear the joint the steel band must occupy a level where it

is less effective in keeping the knee extended. If both of the lower limbs are paralyzed, the patient creeps or relies on a bearer or a wheel-chair. In

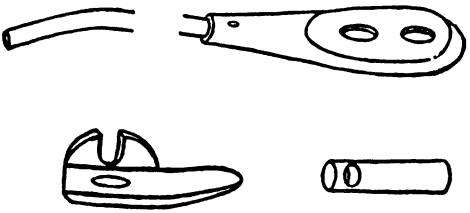


FIG. 32.—Details of "Lever Release."

such a case the application of a brace to each limb renders locomotion with the further aid of a pair of crutches entirely practicable, as is illustrated in Case IV. (p. 57).

TALIPES CALCANEUS.

Paralysis of the fibres which move the tendo Achillis causes a very serious locomotor disability, but one easily overcome by mechanical means. When the action of the heel cord is eliminated the patient cannot stand on tiptoe and his weight is necessarily concentrated on the heel. The result is talipes calcaneus, which implies an unimportant deformity, but entails a serious disability in which the anterior part of the foot is entirely useless. The limb in locomotion is reduced to the condition of a peg leg. It is an example of *non-deforming club-*

foot. The term club-foot is rather loosely applied to all the varieties of talipes. It might well be limited to varus, which reduces the foot to the appearance of a wooden club. The other varieties (valgus, equinus, and calcaneus) are attended by disability rather than deformity. An extreme case of calcaneus, however, presents a remarkable deformity with its magnified heel and insignificant toe, features which are quite invisible when the foot is dressed. Acquired, or paralytic, calcaneus is readily mistaken in the very young for congenital calcaneus, which is of extremely rare occurrence. An example presenting the resistance of congenital equino-varus would be well worth a careful description. The few cases reported have yielded to little treatment or spontaneously even before the treatment proposed could be applied. In an ordinary case of paralytic calcaneus hopeless elongation of the heel cord soon appears. Sanguine confidence in reconstructive surgery has led to division and shortening of the tendon by sutures; but its elongation, being the result of sheer inability to sustain weight, may be expected promptly to recur after such an operation. The condition in talipes calcaneus resembles that caused by amputation at the tarso-metatarsal junction, which was rudely performed by the American aborigines when they wished to prevent the escape of a captive slave.

"The Human Wheel."—In an ingenious analysis of human locomotion, Dr. Holmes wrote: "Walking is a perpetual falling with a perpetual recovery. Man is a wheel with two spokes, his legs, and two fragments of a tire, his feet. He *rolls* necessarily on each of these fragments from the heel to the toe. If

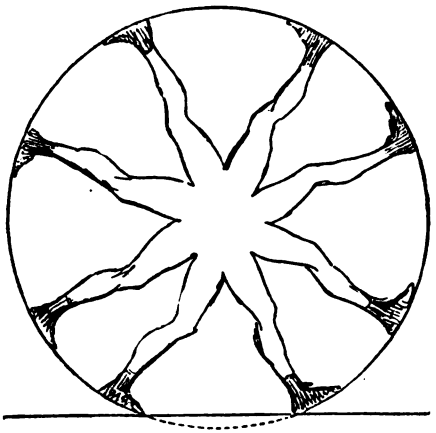


FIG. 33.—"The Human Wheel" (O. W. Holmes, 1863).

he had spokes enough he would go round and round as the boys do when they 'make a wheel' with their four limbs for its spokes. But having only two available for ordinary locomotion, each of them has to be taken up as soon as it is used and carried forward to be used again, and so alternately with the pair." Observation of the gait of a patient crippled by this form of paralysis shows that some of the felloes are absent from the human wheel.

The result is irregular locomotion or jolting progression.

The Strain on the Tendo Achillis.—An obvious function of this tendon is to support the body on tip-

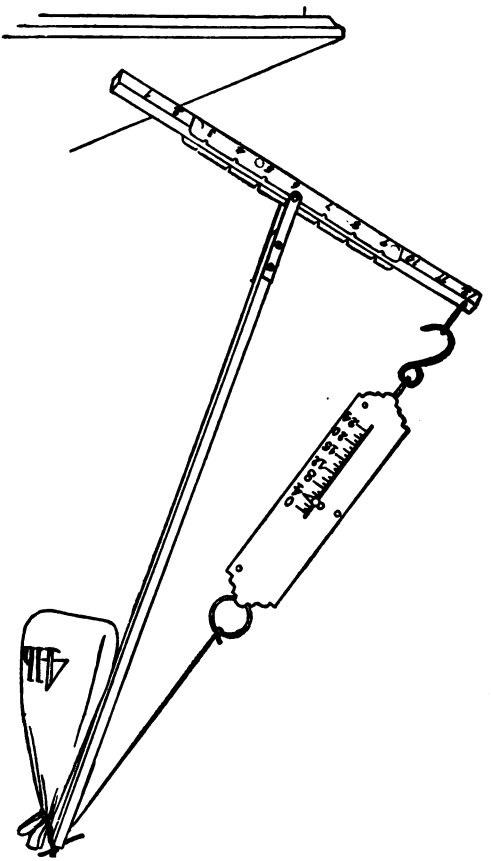


FIG. 34.—Demonstration of Adverse Lever at Ankle-joint. First Position, in which the Strain on the Tendo Achillis Equals the Weight of the Body.

toe. The extravagant size of the muscles found in the calf is accounted for by the fact that they do their very exceptional work at the great disadvan-

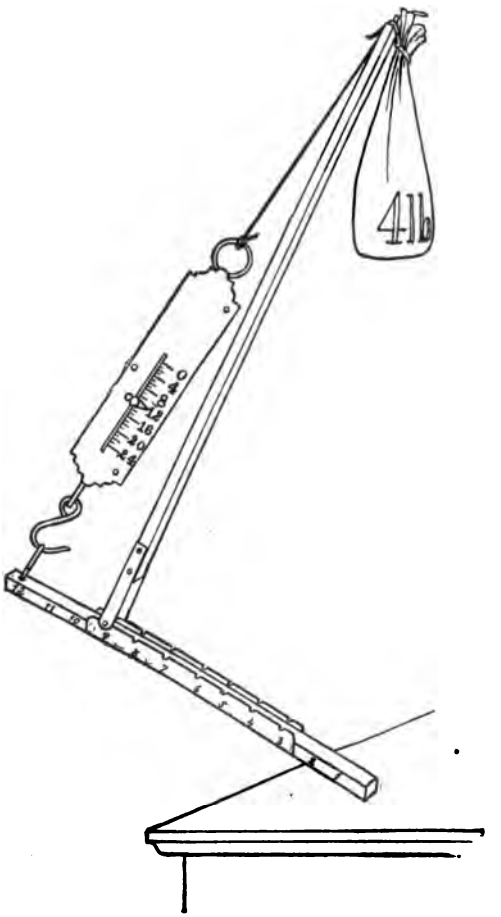


FIG. 35.—Second Position, in which the Strain on Tendon is Trebled (1890).

tage of a remarkable adverse lever at the ankle-joint. The strain falling on the heel cord may be appreciated experimentally by a device which shows that treble the weight of the body represents the tension on the tendo Achillis. In Figs. 34 and 35 the weight of the body is represented by a four-pound bag of shot. The machine being held on a table, the balance is seen to vary in its registry when the joint representing the ankle is moved to different points between the heel and toe. When the joint is near the toe a small fraction of a pound is registered, but when it is near the heel the index points to twenty pounds or twenty-four pounds. In Fig. 34 the ankle

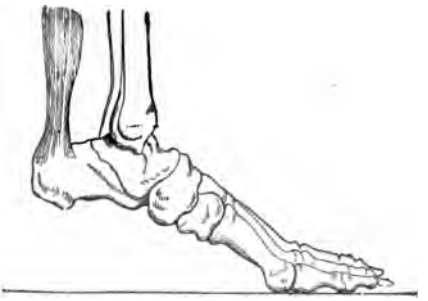


FIG. 36.—Relation of the Joint to the Tendo Achillis and the Toe (Marshall, 1863).

is midway and the balance reads four pounds, showing that if the ankle were at this point, the strain on the tendon would be that of the weight of the body. In Fig. 35 the joint is three inches from the heel and nine inches from the toe, which approximates its

relative position in the foot as shown in Fig. 36. In this position the scale reads twelve pounds, or three times the weight of the shot, demonstrating that if a boy weighs one hundred pounds, the tiptoe strain on his tendo Achillis is three hundred pounds. Practically the strain is often greater, being the sum of weight plus momentum. The lever present is of the second order, in which the weight is between the power and fulcrum as seen in Fig. 37, where the forces in equilibrium about the fulcrum, C, are the upward tension of the heel cord, T, and the downward pressure of the tibia, D B, at B, represented by R. The moments being equal, $T \times AC = R \times B C$. As R is the resultant of the tension of the heel cord and the resistance of the ground at C, equal to the weight of the body, represented by W, $R = T + W$. Therefore $T \times AC = (T + W) BC$, or $T \times AC = T \times BC + W \times BC$, or $T \times AC - T \times BC = W \times BC$. But $AC - BC = AB$. Therefore $T \times AB = W \times BC$, or $T = \frac{W \times BC}{A B}$. If now the weight of

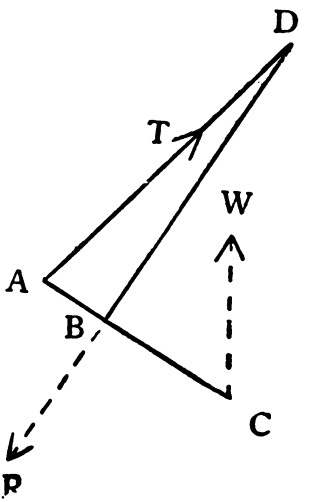


FIG. 37.—Mathematical Demonstration (1890).

the body is one hundred and fifty pounds, and the distance from the ankle to the toe six inches and that from the ankle to the heel three inches, the tension is $\frac{150 \times 6}{3}$ or $\frac{900}{3}$, or three hundred pounds. Dr. Wirt reached practically the same conclusion by the use of cosines.

Very little deformity is produced by either an elongated or a shortened heel cord. But in their effect on locomotor ability they are widely different.

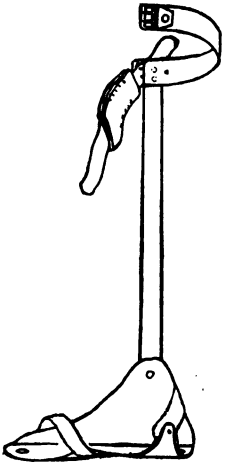


FIG. 38.—Brace used in Case II., Talipes Calcaneus (1890).

A short tendon, unless it is excessively short, causes no lameness. It does not prevent a perfect gait and prolonged exertion in dancing or on a march, and it may be useful in maintaining the equine foot when factitious length is desired for a shortened limb. Dr. Hibbs has made an important study of a series of cases in which subcutaneous division of the tendon had seriously affected its relation to the muscles of the calf. Civilized man assumes few positions which are interfered with by a moderately short tendo Achillis, while a lengthened tendon urgently demands compensation. This may conveniently be found in the

application of a brace such as is shown in Figs. 38, 39, and 40.

Treatment.—The steel band at the upper part of the brace gives attachment to buckles which receive a strap against which the patient kneels when throwing his weight on the brace. When rising on his toe he has a composite sensation of standing and kneeling. The pressure of kneeling is felt near the tubercle of the tibia, and to this point is transferred the callous condition of the ball of the foot, and here frequently is found an adventitious bursa of considerable size. A vertical upright affords relief, but a better effect may be obtained by inclining it backward experimentally until the inclination is found at which walking is most easily done. Such a brace cannot of course furnish the active power which the muscles of the calf exhibit in running and jumping, but it gives sustaining power to the anterior part

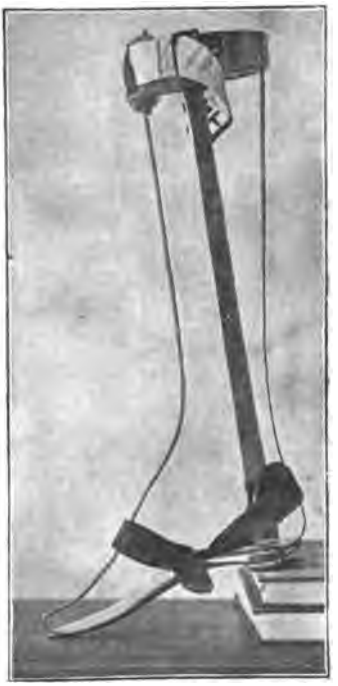


FIG. 39.—A Later Brace (1898).

of the foot and restores normal walking, in which the patient rolls from the heel to the toe. The upright may readily be inclined backward by bending the foot-piece downward when it is a simple tread without a riser, as shown in Figs. 39 and 40. These braces weigh two pounds three ounces and one pound three ounces. They are worn by an adult and a child respectively. If, however, calcaneus is complicated with lateral deviation, the riser necessary for the correction of varus or valgus prevents bending of the tread, and the upright of such a brace as is seen in Fig. 41 may then be bent by experimental blows with a heavy hammer until the proper angle is found, and in subsequent braces a straight upright may be set at the determined angle. A joint at the ankle is unnecessary. It adds to the cost, is useless, and soon wears out under the rapidly repeated blows which attend locomotion. The brace is worn over a stocking for comfort and under another stocking for concealment. Worn during adolescence, such an apparatus abolishes present lameness



FIG. 40.—A More Recent Brace in which the Upright and Tread are of One Piece (1902).

and lessens cavus in after-life. It secures remarkable excellence in walking, whatever may be the hypertrophy of the heel and the atrophy of the anterior part of the foot.

CASE II.—*Right Talipes Calcaneus.*—In 1879, a girl eleven years old had been lame for several years following an attack of "worm fever." She had characteristic inability to stand on tiptoe with the affected foot, an enlarged heel, and a wasted limb. The brace seen in Fig. 38, weighing one pound and eight ounces, restored ability to use the anterior part of the



FIG. 41.—Case II., Standing Tiptoe with Help of Brace (1885).

foot, and corrected asymmetry of gait. An instantaneous photograph, taken in 1885, is copied in Fig. 41, when the affected leg, from atrophy of the muscles of the calf, was nearly three inches smaller than

the well one. In 1890 she wrote that the brace maintained a normal gait and was always in use out of doors, and when housework was to be done.

PARALYTIC TALIPES VARUS AND VALGUS.

Infantile paralysis is the cause of several other forms of disability in locomotion. If the muscles on one side of the leg are paralyzed, the foot turns in the other direction. As muscular failure is the cause of acquired talipes, it is necessary to understand the part which the muscles take in locomotion.

Mechanics of Locomotion.—The common idea that the muscles push the body along is not in accordance with the facts. They may do so when a man climbs a tree or ascends a steep hill, but ordinary walking is a complex and yet a simple procedure in which the muscles do not play a very heroic part. First the body leans in the selected direction, then the feet swing forward one after the other, and the act of walking is completed by muscular contraction, which simply holds the feet steady under the weight of the advancing body, which falls first on one foot and then on the other, in accordance with Dr. Holmes' view that walking is a perpetual falling with a perpetual recovery. Illustrations are found in the leaning figure of a little child just beginning to walk and in that of a man in alcoholic titubation. The spectators look for

a fall which seldom comes. It may be said that the faster one walks the more imminent is the perpetual falling, and the more instantaneous the perpetual recovery. Success in a race evidently depends largely on one's superior ability to get the feet under the body as it falls forward. It may not be easy to give up the idea that the feet and legs push the body forward. The foot certainly spurns the ground in the wake of the runner in a very vigorous manner, but the recoil of this stroke simply propels the foot forward as it hastens to receive the weight of the falling body.

Talipes Varus.—With this understanding of the mechanics of locomotion, it is interesting to note that when the weight of the body falls on the limb in the act of walking, the muscles on all sides responding to a call for concerted action instantly contract by a common reflex impulse to maintain the stability of the foot. At this crisis, if those on the outer side, for instance, are paralyzed and unable to obey the call, those on the inner side, suddenly contracting without opposition, throw the foot into talipes varus, which the weight of the body and the blows of locomotion soon aggravate and which growth presently makes offensive and irreclaimable.

Contrary to public opinion, cases of club-foot are more commonly of paralytic than of congenital origin. A foot deformed at birth is recognized at once. It

is apt to receive prompt attention in an early, plastic, and rapidly growing stage, when it is easily made to grow straight. But incipient paralytic club-foot is insidious. When the trouble is noticed there is simply a defect in gait which it is hoped will be "outgrown." Being painless, and not severely disabling, it is apt to be neglected until the shortened fibres and misshapen bones seriously oppose restoration. If such a foot be taken in hand at once the bones will be found in normal shape and the fibrous structures will be relaxed. In this stage reduction is easy, the appearance being that of the foot seen in Fig. 10 (see p. 10).

Treatment may be the same as that described in the later stage of congenital varus. The foot should be held by a brace in its normal shape until growth and bodily weight confirm restoration (pp. 9–14). The treatment of congenital varus is generally rewarded by the full measure of success, but the result of treatment in a case of paralytic varus will probably be marred by the presence of paralysis in other parts of the limb. Not uncommonly the brace must extend above the knee to reinforce the extensors of the leg while the varus is under correction.

Talipes Valgus.—If the muscles on the inner side of the leg are paralyzed their opponents will produce valgus, a variety of talipes less deforming and disabling than varus, and usually overshadowed by the

concurrence of calcaneus, which is more serious in its effect on locomotion than valgus but fortunately more easily managed. Deformities of the foot simulating the effects of infantile paralysis have their rise in the disintegration which undermines the bones in locomotor ataxia. An instance of tabetic valgus is shown in Fig. 42. The abnormal muscular action of Friedreich's disease produces similar results. In these cases the primary affection is so disabling, locally and generally, that mechanical relief is seldom practicable. In favorable conditions, however, purely prosthetic apparatus is useful in giving stability to the ankle, lateral support in Charcot's knee, or stiffness to the knee, by the action of an automatic joint, prolonging the period in which walking is possible with the aid of crutches.



FIG. 42.—Tabetic Talipes Valgus. Man, Thirty-five Years Old, New York Hospital (1898).

DETAILS OF TREATMENT OF PARALYTIC DISABILITIES.

In persistent varus, as in all cases which require pressure on prominences near a joint, metallic contact should give way to webbing under convenient adjustment by buckles so distributed as to draw the deformed part into a recess formed by bending the frame of the brace. When pressure is to be made on the shaft of a bone, however, as in the reinforcement of the extensor femoris, illustrated in Figs. 27 and 28 (on p. 36), the bone will be found partially cushioned by subcutaneous tissues, and care should be taken to bend and twist the steel till its whole surface of contact is evenly applied to the bony surface receiving the pressure. Padding and protecting wads do imperfectly and uncomfortably what may be better done by conforming the steel frame of the brace. As apparatus of this kind furnishes support which the bones fail to give, it may be likened to an outside skeleton, like that of a lobster or of a crab, but applied with difficulty to the sensitive skin. In the presence of even this hindrance a supporting apparatus may be so well designed and fitted as to preclude a demand for cushions and padding, the absence of which will simplify the application and make prominent its essential mechanical features. In a reasonable time the skin becomes callous and ceases to

resent pressure, and the patient readily accepts inconvenience if locomotion is made easy and effective. Occasional breaks in the steel show the points that require strengthening and prove that the brace is doing under strain what was intended. In some cases it is a good plan to have braces made in duplicate, so that repairs may be made without inconvenience. To adjust such an appliance and to keep it progressively effective during growth and the development of tardy muscular power require considerable time and attention, but otherwise the expense is not great and should not forbid this relief to those who in straitened circumstances stand more in need of it than others.

The Importance of Early Treatment may be emphasized by a consideration of the unhappy condition of quite a number of adults who suffer from various degrees of lameness, some of them being so disqualified for locomotion as to require bearers and wheel-chairs. Treatment of a case of this kind may fail because of the difficulty which an adult has in accommodating himself to new restraints and supports, things which a child does not object to and soon enjoys if they extend his radius of play and mischief. Some of this hesitation is reasonable and excusable because of the time taken for defective groups of muscles to develop the power called for and necessary before the appliance can give increase of ability.

Neglected muscles respond rapidly to such demands in childhood. They may not be expected to answer so promptly later in life and the adult will not so readily endure the uncomfortable and unaccustomed fatigue which is the preliminary and accompaniment of muscular development.

CASE III.—*Disability following Infantile Paralysis.*—A man, 35 years old, had spent most of his years on crutches. His disability had received a great variety of treatment and mechanical attention at home and abroad. The anterior part of the left foot was useless from defective leg muscles, and the right limb was disabled by paralysis of the anterior muscles of the thigh. With these two points reinforced, he would have been in a position to dispense with crutches, still walking, of course, with considerable lameness. When a trial was made, beginning with a brace for the affected foot, it was seen that it called for the use and development of other groups of muscles also, in the extremity and even in the trunk. This would have been brought about easily in the case of a child, but it was too much for the matured muscular system of an adult, and withal called for such a change in the man's habits and settled beliefs as to his physical condition that the treatment, hesitatingly begun, was rather eagerly abandoned.

On the other hand, assistance of this kind offered

in childhood has in many instances favored the development throughout the time of growth of important muscular groups and has thus secured comfort and ability and nearly symmetrical locomotion in after-life. One such patient, a woman, says that mistaken friends advise her to lay the heavy contrivance aside, but the whole muscular system having made its growth in accord with the support which a part has received from the brace, she finds it too useful to be discarded. Another always wears the brace when in "company" in order to appear well, the absent muscular power having its place taken by the artificial support, and the developed accessory muscles helping to complete the symmetry of locomotion.

CASE IV.—*Disability following Infantile Paralysis.*—A noteworthy instance is that of an apparently healthy boy who at the age of 14, was unable to stand on account of a belated attack of infantile paralysis. Apparatus was applied for automatic fixation of each knee in the extended position, allowing him to walk with crutches, and voluntary release of fixation when he desired to flex the limbs in sitting. Thus assisted and incited, the unused muscles in various parts of the body developed with exercise and the completion of growth. In this way he was enabled as a boy and as a young man to do more than the average amount of work without any personal aid whatever, and he now enjoys an active legal practice, not neg-

lecting vacation sports and pastimes ashore and afloat, although his attenuated lower limbs are in marked contrast with an heroic torso and upper limbs. That he is not limited to locomotion in a wheel-chair is owing to the fact that the failing muscles and joints received mechanical encouragement at the time of growth, an advantage which might well be accorded to every case of this affection.

Recognition of Mechanical Surgery.—It is evident that an instrument applied for the relief of disability following paralysis supplies a defect in the anatomy. To that extent it is a prosthetic apparatus. It need not, however, on that account be omitted from the armamentarium of the surgeon. The application of braces of all kinds is passing into professional hands from those of the instrument maker. In the dark ages, when surgical work was in the province of the barber, the medical men of the day probably waived professional convention when they ventured to take up the lancet and bistoury.

In 1862 Dr. Stephen Smith wrote: "It must be evident to every one that mechanical surgery is a branch, and a most desirable one, of surgical science and art. It is not simply a branch of mechanics to which any ingenious artisan can successfully turn his attention; it requires also an accurate knowledge of anatomy, of physiology and of surgery. Rationally, the mechanical surgeon must be a thoroughly edu-

cated physician as well as an inventive genius. Medical men of real merit have recently entered this field of service and already the ripe fruits of skilled labor begin to appear." The far-seeing wisdom of this observation is attested by the fact that within six years after these words had been penned, The New York Hospital for the Ruptured and Crippled and The New York Orthopædic Dispensary and Hospital had been established or incorporated. The work done by these institutions prepared the way for the present wide recognition by charitable, educational, and governmental interests of the value of this field of special study and effort.

An Orthopædic Laboratory.—The following statement of instruments and materials is considerably reduced and modified from a schedule presented by Dr. Schapps, when he described the equipment of a new orthopædic dispensary. These appliances are necessary for the application and modification of braces made to order from soft steel by an instrument maker: Work-bench, vise, screwdrivers, riveting hammer, files, flat and cutting pliers, monkey-wrenches, Stillson's wrench, hack-saw, cold chisel, punches, centre-punch, copper rivets No. 13, various lengths, burs, steel wire for rivets, rivet set, shoe knife, scissors, snips, oil stone, can of oil, machine screws, broaches, taps, hand vise, eyelets and set, leather punch, foot drill or lathe, twist drills, machine

for general sewing, truss leather, felt, buckles for webbing and leather, cotton surgical webbing, pans for holding rivets, burs, screws, buckles, etc.

Apparatus not only Prosthetic but also Preventive and Therapeutic.—A brace applied in a case of infantile paralysis has especial value for a growing patient because its effect is not only to improve the present gait but also to induce related structures, which would otherwise have remained dormant, to develop by exercise and the increasing demands of coördination, until they play an important part in the attainment of ability and grace. An adult would of course gain some advantage, but far from the full benefit which would have been his if all the machinery of locomotion had made its growth under the influence of timely reinforcement of the deficient part.

These disabilities require early and very prolonged attention in practice. When the lameness of a child is recognized as the result of infantile paralysis and acknowledged to be incurable the limp is considered unfortunate, of course; but if the condition does not include absolute disability, it as a rule receives little serious attention in the way of treatment. Presently, however, as the child grows, the misfortune becomes more conspicuous. The machinery of locomotion falters more and more under increasing weight, and when contractions and deformities are added to atrophy and muscular insufficiency, acute attention

is aroused and braces are sought and operations are performed. A better plan is to assume that mechanical assistance is required at the outset—and will be necessary throughout the time of growth, and afterward. It is true that treatment thus prolonged and troublesome can only palliate and not cure. It implies also exacting attention to mechanical details, frequent supervision, and many alterations and adjustments of apparatus in response to the demands of growth and increasing ability. Improvement in walking is seen at once, but more important benefits will accrue later when it is found that continued use of the brace promotes symmetry of the affected limbs and flexibility of the joints, conserves muscular power which would otherwise have been lost through disuse, develops extensive related groups of muscles in other parts of the body, and preserves or restores various allied functions and abilities which materially add to the efficiency and comfort of the adult. When practicable, this end is certainly preferable to the result of systematic neglect, or a spasmodic resort to treatment whenever its repetition seems to be especially necessary. In this direction a change is noted in the views of physicians and of the public.

Orthopædic Surgery as a Specialty.—While the troubles seen in the wake of infantile paralysis may be greatly relieved, the nerve lesion persists, and from

the nature of the case there will almost certainly be a lasting residuum of disability. The result of treatment falls short of perfection, but the same may be said as a rule of the treatment of spinal deformity and joint disease, and in fact of nearly all of the affections included in orthopædic practice. This has been advanced as one of the reasons among others for the existence of such a specialty as orthopædic surgery. The limitations of achievement are so conspicuous and so sure to bring discredit upon medical authority that it seems to have been agreed that the inevitable may well be transferred to a specialist, who collects what is known on a certain subject, so that when the end of treatment is reached it may be said that the patient has received all that the science of medicine in its present state allows. The orthopædic surgeon may be the depository of exceptional knowledge, but his work includes not many opportunities to obtain brilliant results or to achieve operative success, which is so greatly and so justly admired in the public mind. He throws a deformed foot into a new attitude in which increasing activity and growth promote and insure symmetry. He gives to a tuberculous joint a new environment favorable to natural repair and recovery with an unexpected restoration of locomotor ability. He provides a reënforcement for a paralyzed limb which meets the immediate necessity of the case and secures future activity and

comfort. A studious application of the methods of precision on which he relies cultivates his aptitude for mechanics and fosters his respect for whatever is physically demonstrable. If he adds to natural ingenuity an inherited or acquired preference for slow and sure, rather than rapid and indeterminate methods, he is in a position to witness and reverently to assist constantly recurring natural miracles in repair and recovery, not forgetting the friendship of his little patients, their pretty bashfulness, ready confidence, irrepressible cheerfulness and graceful acceptance of what is, alas, inevitable. The combination in their young lives of childish and heroic qualities suggests a fantasy in which birds and wild flowers act a tragedy and improve the precepts of stoic philosophy.

CHAPTER III.

TUBERCULOUS JOINT DISEASE.

An Affection of Childhood.—Its Causes.—Tuberculosis of the joints is especially a menace to childhood; and yet in this period, when the vital processes are at their best and growth and development are active, it would seem that natural resistance to general diseases should be alert and give protection from dangers of this kind. In early youth the circulation is rapid and full. Children are not easily deprived of their share of respiratory activity. They are not given to introspection and melancholy which has been thought to favor the approach of general or constitutional disease. Their habits are far from sedentary. Their minds are free from worry and their bodies from overwork and long hours without rest and recreation. By this process of exclusion, their danger may perhaps be referred to some mismanagement of alimentation. Some unfortunates are, from sad necessity, denied sufficient food. Others perhaps suffer because prudent economy finds easy expression in a scanty allowance to the younger members of the family, reenforced by a common and not altogether unreason-

able idea that it is bad for a child to eat too much. Overeating may of course induce acute disorders of brief duration, but, on the other hand, prudence of this kind may easily lead to the more serious mistake of opening the door for chronic affections by withholding sufficient nourishment. Certain young parents who have no reason for economy seem to have an idea that the precious object entrusted to their possession has delicate and sublimated qualities which, for a time at least, exempt it from the common necessity of an abundance of good food. Cases are very rare in which trauma can be proved to have been the cause of joint disease, although many "previous histories" include a story of some injury, from a fall or otherwise, which preceded or accompanied the first symptoms and which is supposed to have caused the trouble.

Operative and Mechanical Treatment.—While tuberculosis in the tissue of a vital organ generally leads to the most untoward result, the same affection developed in a joint is seldom fatal. With the favorable conditions accompanying the youth and growth of the patient recovery may be considered assured in advance. A method may be almost within our reach of arresting or favorably modifying this morbid process, wherever it may have gained a lodgment, and of thus prolonging life and lessening the sum of deformity and disability. Until this promise shall have

been fulfilled, however, it is useless to undertake positive treatment of tuberculous joints. In these days of brilliant and painless operations, and wonderful discoveries in physics, it is not easy to wait for natural repair and recovery. The most interesting thing in surgery is the arrest of pain and the transition from peril to safety which often follow a bold operation. The confident surgeon is like a military captain who by a well-timed advance changes defeat into victory, returning with the priceless trophy of life and health. But this achievement has not yet been seen in the surgery of tuberculous joints. A malignant growth may be successfully excised, but not the involved structures of such a joint. The earlier deposits have been traced, before and after infection, and withdrawn by Macnamara, Sherman and Bartow, and by other operators, but this procedure is not as yet established. The initial focus, in one or the other of the bones composing the joint, is presently followed by others, superficial or remote from the articular surface, some of them coalescing in depots of broken-down tissue. This ambuscade leads to postponement of action until the joint is well occupied by the disease. At such a time conservatism may seem to indicate thorough excision, but with the risk of sacrificing useful parts while overlooking remote points of diseased action. Among so many conditions implying doubt and undermining

confidence, mechanical surgery happily encourages a reliance on wisely planned expectation, which brings relief from pain and gives full assurance of timely intervention by natural reparative processes.

The conservatism which brought honor to the name of William Fergusson substituted exsection for amputation, but the surgery of to-day conserves not only the limb but every possible structure. All the joints and functions are to be retained rather than surrendered, especially in the case of a growing child. The fragments are to be kept and cherished because they will share in the development of the whole growing and learning body, a development stimulated by Nature's ever-present effort to supply what is deficient. This consideration is less important in the treatment of adults, who may well desire speedy recovery. But at the time of life when tuberculosis usually attacks the joints, prolonged treatment gives opportunity to direct the natural growth until the "alchemy of patience" reveals ultimate symmetry and ability. At this time internal resistance to disease and natural efforts to repair the effects of disease may be expected to promote the development of tissue, structure, and function.

Intelligent Expectation.—Observation and experience have matured the opinion that joint disease cannot be cured in the ordinary sense of the word. While it cannot be cut short, it is equally certain that

it will recover, albeit with some disability, and the physician who takes that ground at the beginning of such a case, in an adult or in a child, or as regards any part of the skeleton, will see his opinion proved by the event. He will save his patient from severe pain inflicted in vain efforts to retain or restore mobility. He will probably shorten the duration of the disease and certainly lessen the degree of ultimate ankylosis by intelligent efforts to subdue inflammation. To the method of treatment thus outlined has been applied the term expectation, a word which is not strictly correct, because what is called expectation in these cases is characterized by radical changes in environment, not the least of which is the substitution of rest for activity. The word *rest* does not mean very much if it implies merely cessation of work or the avoidance of fatigue, but it means a great deal when applied to a regulation in which an organ is absolutely restrained from its customary function. A prescription of this kind is common in medicine and surgery, but probably no more striking example will be found than that in which a joint is not only prevented from motion but is also released from the duty of carrying the weight of the body.

The Prevention of Ankylosis.—At the first view it seems unreasonable to deprive a joint of motion in a crisis in which its mobility is threatened by disease. It has been found difficult to give to ankylosis its

proper value in the terms of this therapeutical problem. From a review of the morbid anatomy of this affection, it is evident that when inflammatory action has swept through a joint the results resemble somewhat those found in a house tested by a conflagration. The bones are charred, so to speak, the articular surfaces are distorted, the ligaments are fused and warped, and the synovial membranes are rendered useless. Normal motion thereafter is out of the question. But it is also evident that the destructive process should be stopped as soon as possible. Thus far the surest method of subduing inflammation is an arrest of function. It is indeed the only effective resort. Fortunately it is applicable to a certain extent in every case of joint disease, and the point of practical and urgent importance is to recognize the necessity of it at the earliest possible moment.

Fixation of an inflamed joint will lessen ultimate ankylosis by moderating the inflammation and abating the quantity and density of its obstructive products. It is credibly stated that fixation of a healthy joint for even an indefinite time is powerless to produce ankylosis. It will interfere with normal motion of the joint, but the impairment of mobility produced in this way will be overcome in the course of time by effort on the part of the subject. This disability is very different from ankylosis following inflammatory disease, which is, with rare exceptions, permanent.

Let fixation, therefore, be applied as early as possible, and with uncompromising persistence, with the knowledge that, so far as the joint is healthy, the application is harmless, and with the assurance that, so far as the part is diseased, fixation will, by checking inflammation in the joint, increase its ultimate mobility. It is noteworthy that, while the local environment of a joint in the lower extremities is controlled by mechanical arrest of its functions, the same device modifies the general environment of the patient by substituting for the sick-room a life of activity out of doors.

An Early Diagnosis is especially valuable in joint diseases of the lower extremity because on the date of the diagnosis depends, more than in many medical and surgical emergencies, the character of the prognosis. Treatment prescribed before the foci of morbid action have begun a destructive career under the incitement of habitual traumatism should, by averting violence, induce resolution with retention of motion and exclusion of deformity. That affections corresponding to hip disease and white swelling of the knee are almost entirely absent from the upper extremity indicates that tuberculous deposits are harmless in bones that are exempt from habitual violence. It is no time for timorous hesitation or dread of making a mistaken diagnosis. Dr. Fayette Taylor would say that the house is on fire or it is not on

fire. Protective treatment, which is the first and chief requirement of such cases, is no real hardship for a few months in childhood or adolescence, it interferes in no serious way with a child's happiness, and may secure ability and symmetry for the rest of his life. To omit or postpone such a precaution may open a door to permanent disability and deformity.

Chronic Synovitis.—When synovitis occurs in the course of tuberculous disease of a joint it is second not only in time but also in importance. Occurring thus, it requires no special attention. No reasons have been found in the clinical history or in the morbid anatomy of diseases of the joints, for the fear that synovitis may "run into" osteitis. The two affections resemble each other in being of long duration and presenting a disposition intractable to any form of positive or active treatment. Non-rheumatic inflammation of the synovial membrane may interfere with the action of a joint through excessive effusion, but the ligaments retain their properties and the neuro-muscular element of inflammation of the bones forming a joint is absent. When simple or primary synovitis finally disappears it rarely leaves disability or deformity.

Whether the joint involved in tuberculosis is large and difficult to treat or small and easily controlled, a long time will almost surely be required for the restoration of the part to health. Although the princi-

ples of treatment are few and simple and easily carried out, their application does not often meet a quick response. The beginning of the process of repair is apparently postponed until the occurrence of some general reaction, the nature of which is not clear.

It is well, therefore, to undertake the treatment of such cases with the knowledge that recovery will be a tedious process. Excepting in those cases in which a very early diagnosis is made, the duration of treatment will probably cover several years. As an offset to this inconvenience, good functional ability, albeit with some lameness, may be confidently predicted. This outcome is assured, in an absolutely favorable environment, by the presence of youth and by the assistance derived from the vital activity which accompanies growth. A splint is an unwelcome burden and an annoyance, but when applied to an adult it seldom entirely precludes the pursuit of ordinary business. Still less does it interfere with the education and amusements of a child, whose buoyant indifference to personal inconvenience softens the hardship of mechanical restraint. Surely much can be done during the plastic years of juvenile growth to avert ultimate deformity and disability.

CHAPTER IV.

WHITE SWELLING OF THE KNEE.

THAT an intimate knowledge of disease lies at the foundation of practice is not held by the faculty alone. Wherever there is sickness a physician who recognizes a disease, traces its origin and foretells its course is at once credited with ability to cure it. Pathology rightly holds the seat of honor in the temple of Æsculapius. But how changeful is pathology! How fickle a divinity! Mr. Adams (1854) wrote that the life of a pathological doctrine was about thirty years. We learn, but with the prospect of having to unlearn, and the all-wise, unwise public senses this and when in trouble goes doubtfully away "trembling, hoping, lingering, flying," to fanes where the divinities are not only fickle but meretricious. In the consideration of white swelling of the knee, however, we recognize a pathological feature which has all the stability of exact science. Inflammation here is prolonged by the continued use of the affected joint, which goes from bad to worse so long as the patient stands and walks.

TREATMENT.

Diagnosis should therefore be followed by release of the limb from duty. Night brings the recumbent position, and day should see the application of an ischiatic crutch, or some other device which secures **protection** of the joint from the weight of the body and provides for walking while only one foot reaches the ground. This was formerly thought to be impossible. "*Mais le corps humain peut-il conserver pendant des mois entiers l'attitude vertical, touchant le sol par un pied seulement? Evidemment non; c'est au-dessus de ses forces. L'avenir nous réserve sans doute de grandes surprises, et ce qui est impossible aujourd'hui deviendra peut-être facile demain.*" This disposition of the limb, by improving its environment, will hasten the natural reaction toward recovery.

Fixation.—The evils of weight bearing being forestalled, it remains to bring about the suppression of motion. Arrest of function is indicated in all cases of inflammation. In ophthalmia light is excluded and vision is placed in abeyance. Adhesive bands limit expansion of the chest in acute pleurisy. As respiratory activity contributes to the incurability of phthisis pulmonalis, occlusion of a bronchus might be followed by limitation of the area of serous surfaces, by evacuation of the products of inflammation,

and finally by cicatrization, processes which often take place in tuberculous joints. The pain of an advanced stage of joint disease requires arrest of motion, or fixation. It was the opinion of Mr. Brodie that the efficacy of "Scott's dressing," a famous remedy for white swelling of the knee, depended on layers of adhesive plaster applied in such numbers as to limit the motion of the knee, an effect which might have been produced by the oxide of zinc of Mr. Brodie's day but not by the flexible tropical gums which were proposed in the manufacture of plaster by Mr. Eyre in 1848 and perfected by Dr. Martin in 1877.

The Fear of Ankylosis, *l'ankylophobie* of the French disputants, still confuses the treatment of this affection, as well as of other forms of joint disease. A physician naturally hesitates before deciding that a child, apparently healthy, has so serious an affection as white swelling of the knee, and if he fears that resting the joint will cause ankylosis he fails to apply the most efficient remedy for inflammation and the surest preventive of ankylosis. Recognizing the fact that impairment of motion is not only a sign of disease, but also an effort of nature to allay inflammatory action, let him promptly aid this effort by artificially promoting fixation. Safety lies in preparing for impending ankylosis and in seeking to lessen its degree by all the means at hand.

Pressure and Counter-pressure.—To give absolute fixation to the hinge joint at the knee the simplest form of retentive apparatus is quite sufficient. It

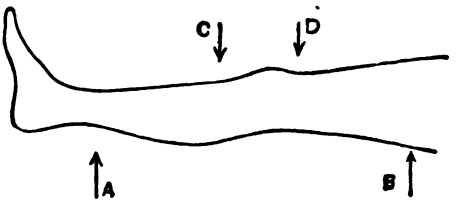


FIG. 43.—Points of Pressure and Counter-pressure for Fixation of Knee Joint.

should make pressure at the points indicated by *C* and *D* and counter-pressure at *A* and *B* in Fig. 43. A splint having this action is outlined in Fig. 44, and is seen applied to a limb in Fig. 45. A similar splint worn by an adult weighed one pound and three ounces. The firm application of such a splint is attended by what appears to be an increase in the size

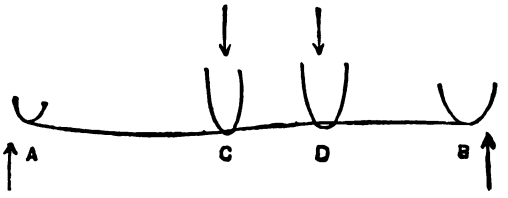


FIG. 44.—Outline of Brace for Fixation of Knee Joint (1886).

of the joint, caused by repression of the soft parts above and below the swollen knee. There is also an apparent constriction of the limb, which is not real,

because the omission to make pressure from behind forward at this level makes constriction and interference with the circulation impossible. Such a splint also provides for the **reduction of flexion.** Conforming at first with the shape of the flexed limb, the instrument may be kept tightly buckled, and, being straightened from time to time, it will slowly, and with certainty in ordinary cases, draw the knee first into extension and then into hyperexten-



FIG. 45.—Brace Applied for White Swelling of Right Knee. Boy, eight years old, 10° of hyperextension following 30° of flexion.

sion. This painless process is made easy by the cheerful interest and assistance of the patient. It illustrates the mobility of the immobility, so to speak, which marks the early stage of all joint disease. In a painful stage a weight and pulley may be conveniently used to begin the reduction of extreme flexion, but a splint with its advantage of long leverage above and below dominates the joint so powerfully that success is certain if flexion has not become too resistant through delay.

Details of the Fixative Splint.—A plain bar of iron or soft steel is prepared for the posterior surface of the limb. To this are fastened four transverse pieces, curved to half encircle the limb. They are riveted, the middle ones to the posterior and the others to the anterior side of the upright bar. The upper and lower are padded, the others are left uncovered, as they do not touch the skin and have the simple duty of carrying buckles to receive pieces of webbing on which sliding pads mollify pressure from before backward, which is the key to the apparatus. With soft metal and simple tools, a physician remote from skilful workmen may give to his patient relief and the assurance of a straight limb. The same results are attainable by the use of the plaster-of-Paris dressing, which observes the same pressure points. The plaster splint will have to be reapplied occasionally as the knee straightens or else partly divided transversely, as was ingeniously proposed by Dr. V. P. Gibney, and straightened by the insertion of wedges of increasing size.

Experience has taught that the splint is liable to be displaced by gravitation, which may be opposed by lacing the shoe in such a manner as to form from its upper part a cup, or socket, which receives the lower end of the brace and keeps it up. A rotary displacement is also sometimes troublesome. Remedies for this may be found in watchfulness at home,

in experimental changes in the length and shape of the pieces composing the splint, or in the addition of buckles and straps to the upper and lower transverse pieces. In a certain case the apparatus persistently sought the inner side of the limb where it aggravated a preëxisting knock-knee. A piece of steel was therefore fastened, as seen in Fig. 46, to the heel of the shoe at a suitable angle, which was ascertained by experiment, and made to coalesce with the upright by a sliding ring keeper (seen in Fig. 45). Thus controlled the apparatus kept its place behind and to the outer side, where it opposed both knock-knee and flexion.



FIG. 46.—Device for Keeping Fixative Brace in Position (1901).

Knock-knee and Bow Legs.—A similar application should be absolutely effective in the correction of rachitic deformities of the lower limbs, advantage being taken of the natural growth, the increment of which should be enlisted in behalf of the patient instead of being allowed to add to the trouble, in further illustration of the line: "Just as the twig is bent the tree's inclined." It is difficult to see how a crooked limb can be treated with much success while the patient is on his feet, since a large part of the transverse pressure exerted by the brace must be ab-

sorbed in sustaining the weight of a child who is running about all day. If, however, the foot is kept from the ground by suitable apparatus, one foot being treated at a time, or if the patient is recumbent while both of the limbs are under treatment, the chief mechanical obstruction is removed and the way is cleared for the positive action of a simple but powerful lever on long bones in a more or less plastic and tractable state. Success should certainly follow the application of a fixative brace constructed of soft metal, or the use of any other suitable method or material. To recapitulate the mechanical points: the chief direct cause of the deformity, the impending weight of the body, being removed, the plastic condition of the bones (which is the indirect cause) is converted and inclines the deformity to yield to treatment. The instrument should be kept on the side of the concavity of the curve, where counter-pressure is made at distant points by the padded ends of the brace, while pressure is made at the point of greatest divergence by webbing and buckles, the force thus applied being gradually and painlessly increased and the brace being straightened from time to time as the limb straightens. When the deformity has been neglected and has become confirmed by the hardening of the bones, an operation will be necessary before beginning mechanical treatment. Extremely good results follow the operative correction of these

deformities by rapid osteoclasis applied at the upper part of the tibia, as signally demonstrated by Dr. Blanchard.

DIAGNOSIS.

An early diagnosis of white swelling of the knee is of great importance. In the following case an early diagnosis was followed by a perfect recovery.

CASE V. — *Incipient White Swelling of the Knee.* —A girl seven years old, and apparently in perfect health, had been limping occasionally for several months. The range of passive motion was between 20° and 170° of flexion. Attempts at full extension caused reflex resistance and twitching of the muscles of the thigh. There had been no subjective symptoms. The signs included an increase of three-eighths of an inch at the knee, a decrease of three-eighths at the calf, and a decrease of five-eighths of an inch four inches above the patella. Treatment was begun in September, 1899. In the absence of pain fixation was postponed, and weight was removed from the limb by an ischiatic crutch with a high sole on the shoe of the well foot. At the end of a year there had been no further trouble, the swelling had disappeared, and normal motion had returned. In their new environment of quiescence the tuberculous centres, ignited somewhere in the cancellous structures above or below the line of the joint, had evidently been walled off and extinguished, as prob-

ably happens when they menace the joints of pendent limbs, or other favored parts of the skeleton. In September, 1904, four years after treatment ceased, there was no sign of relapse. Motion was perfect and there remained only a slight difference in the measurements of the limbs. The benefit derived from the successful issue of this case was threefold: Dr. Romaine, the physician who made the diagnosis, escaped trouble at a time when it has entrapped many; the specialist recorded a case which did not have the usual residuum of deformity; and the little patient was very fortunate, the happy results of an early and fearless diagnosis.

An early recognition should, in truth, be often accorded to these cases. Unlike their situation in Pott's disease or in hip disease, the affected bones lie near the surface, and their motion (that of a hinge, the simplest in the anatomy) is so obvious that anything wrong may be seen at once. Among the first indications are an inconstant limp, slight increase at the knee, and decrease above and below the knee on comparison with the other limb, impairment of passive motion near the limits of the normal range, reflex muscular action, an uneventful previous history, and the absence of subjective symptoms. When the disease is established, its history, the characteristic white swelling, and a tendency to subluxation serve to distinguish it from rheumatism. A few years ago am-

putation was a common resort in this affection, which in a painful stage leads to many lapses in diagnosis through simulation of malignant disease and acute osteitis.

RESULTS OF TREATMENT.

After white swelling, the patient must as a rule make himself contented with a knee which has no motion. With an ankylosed joint he is indeed unfortunate if the knee is left in a condition of marked flexion. With this result he can of course sit very well, but when he rises the limb is shortened and deformed by flexion; and a still worse condition is developed by the act of walking, in which the weight of the body, falling on a flexed and stiffened limb, takes it at a great disadvantage, so that locomotion is almost inevitably attended by pain and weakness.

Flexion of the knee is therefore the chief evil to be combated in this affection. It attracts attention as an early sign and requires persistent restraint at all stages of treatment. It is liable to recur even after treatment has ceased and especially after an operation has been performed on the bones, as has been forcibly pointed out by Dr. Townsend.

On the other hand, it may be considered as a fortunate result if ankylosis has overtaken the joint when the knee is straight or hyperextended. Sitting will then be inconvenient, but when the patient stands and walks there is no deformity whatever and the

limb supports the body with confident firmness and without pain, although walking will be somewhat interfered with.

In the complex act of walking the foot swings forward to receive the weight of the advancing body, and this requires that the limb be shortened by slight flexion of the knee. When this is prevented by a stiff joint the gait may be improved by raising the heel of one shoe and lowering that of the other one. This simple device, which is almost entirely neglected in providing against this disability, is especially applicable when the affected limb has been lengthened by epiphyseal hyperæmia in the acute stage of the affection. Some defect in the gait will be present, but not enough to prevent effective walking and prolonged effort in locomotion.

As a normal knee may be hyperextended ten degrees and sometimes fifteen degrees hyperextension is to be sought rather than avoided as a result. In this position the broad articular surfaces are mutually adapted to planes of contact and become a safeguard against a relapse to flexion. Not only the surfaces, but also the ligaments of the joint may thus be favorably disposed toward the maintenance of stability in weight-bearing and locomotion. Leaving out of consideration those rare cases in which motion is quite normal, or so wide as to include full extension and enough flexion to facilitate sitting, the best result after

this affection is a knee ankylosed in extension or hyperextension. Limited motion is of but little use if it does not include complete extension. A common result is a diminution of the circumference of the limb, appearing worse than it really is from contrast with a limb which has been overworked and unduly developed. It has no effect on locomotor ability. Subluxation, although a remarkable deformity, is not of itself a seriously disabling incident. If the limb recovers fully straightened subluxation throws the axis of the lower bone somewhat behind that of the upper one, but not enough to compromise support by a straight bony section from the ground up. When abscesses occur they have the appearance of being a grave complication, but like those of hip disease they evidently have no effect on the duration of the affection or the quality of its results. They may, therefore, be left to take their own course. The affected joint calls for protection and fixation while a good position is insured by the maintenance of hyperextension throughout the period of growth.

The want of adequate attention at home can alone excuse recovery with ankylosis in a flexed position, as correction should lie well within the power of so simple a device as a lever. As in many other orthopædic emergencies, success depends very much on the cöoperation of the patient, or, in the case of a young child, on that of the mother or of the nurse,

whom it is often not out of place to remind that the brace is to be worn, not only on the child's limb, but also in her head.

The amount of flexion may be measured while the patient lies on his well side, by holding one arm of the goniometer parallel with the axis of the shaft of the femur, or with a line connecting the trochanter and the middle of the knee, and the other arm of the instrument parallel with the crest of the tibia, when the degree of flexion may be read on the scale. The instrument should occupy a plane parallel with the plane of the leg and flexed foot.

Ankle Disease.—Dr. V. P. Gibney, referring to caries of the ankle in children, expresses a sound practical opinion as follows: "The expectant plan, fully carried out, assures us of more results that are perfect, and more limbs that are useful without the aid of support than does any other plan known to the profession." In the treatment of disease of this joint especial attention should be given to the maintenance of protection from the weight of the body, fixation being sufficiently secured by the action of the muscles of the limb. A patient of Dr. Schapps, affected with disease of the ankle and tarsus, applied to his disabled limb "an old-fashioned peg-leg," which shifted his weight from the useless foot to the flexed knee. He thus promoted recovery *secundum artem* while doing his duty as a fireman.

CHAPTER V.

TREATMENT OF HIP DISEASE.

Basis of Mechanical Treatment.—Hip disease seems to be rated by the public as an incurable disease. It is true that when it is fairly established there is no hope of a return of the joint to a normal condition; but it is far from being a fatal disease. It may be confidently predicted in every stage that the time will come when nature will rally her forces and dictate the ascendency of repair over destruction. Would that it were possible to cut short the morbid process by an operation and thus secure symmetry and ability! Unfortunately the hip patient cannot be cured as if he had a calculus, a diseased appendix, or an aneurismal tumor. And yet the management of hip disease is by no means a matter of perfunctory expectation. Excellent service may be rendered, with abundant opportunity for the exhibition of surgical qualities.

Obviously the first thing to do is to relieve the joint from supporting the weight of the body. It may be borne in mind that the ruthless character of the disease is the result of untoward mechanical en-

vironment. Its counterpart is not found in the upper extremity, where the foci of disease in the cancellous tissue are resolved at an early day, by reason of the exemption of the arm from the labor and hardships attending locomotion.

Something more than this, however, is required in the tedious course of the disease. There are periods in which the pain caused by motion leads the patient to steady the limb by adducting it against its fellow, and even by flexing it against the body where the hands may assist in fixation. In this emergency mechanical treatment introduces what Mr. Thomas termed a fractional degree of fixation, which allays pain, and when the pain has ceased enables the patient to dispose the limb in the position of least deformity. Mechanical interference should promote recovery, directly by inviting resolution, and indirectly by releasing the patient from confinement and invalidism and sending him out of doors.

HISTORICAL NOTES.

Accepted views of the pathology and treatment of hip disease have greatly changed in the last forty years. A distinct advance is seen in a better appreciation of what can be done to modify favorably the course and result of the disease, which of late years is said to be managed rather than cured. Provision

is made for promoting the "natural cure" and for securing the minimum of ultimate disability. In current discussions the misapplied word *extension* has given place to *traction*. Surgeons were formerly troubled by spontaneous dislocation, which is now forgotten. In a warm discussion, Dr. March, of Albany, declared that it "seldom or never took place," basing the statement on "personal examination of about forty pathological museums in this country and Europe," and Dr. George Hayward, of Boston, replied: "It would require more specimens than would fill forty, or forty thousand, pathological museums to convince me that this (related) case was not a spontaneous dislocation of the femur."

The Use of Adhesive Plaster for Traction.—The merits of this rather nice question were presently lost to view when the application of sticking plaster replaced the various painful and clumsy methods which had been necessary whenever it was desirable to treat a broken bone by laying hold of the limb below the seat of the fracture. Traction was thereafter applied in cases of hip disease, not to reduce spontaneous dislocation, but to relieve pain and promote recovery. Prehension of the limb by adhesive plaster in the treatment of fractures had been advocated by Dr. S. D. Gross in 1830, but it was not adopted until attention had been recalled to the subject in 1850 by Dr. Josiah Crosby, one of whose patients de-

scribed his sensations by saying: "It feels as if my leg was in the mud and I was trying to pull it out." This was a homely but hearty recognition of the value of a device which has displaced the handkerchief knotted about the ankle, the buckskin gaiter and similar painful appliances which were parts of the old long fracture splint, and which were doubtless used by Mr. Brodie (1834) and others when they experimented with the weight and pulley in hip disease. A French apparatus described in 1865 made traction in the recumbent position by pressure against the calf of the flexed leg.

Drs. Henry G. Davis and L. A. Sayre simultaneously described the application of adhesive plaster for traction in hip disease in 1860. The injurious effects of muscular action on the joint, and their prevention by traction, became at once the subjects of observation and discussion. Interest was excited to such a degree that in the following year the merits of the new treatment of hip disease were discussed at three successive meetings of the New York Academy of Medicine by Drs. Batchelder, Bauer, Bronson, Gurdon Buck, H. G. Davis, Finnell, Holcombe, Krackowizer, Miner, Parker, Post, Raphael, Sayre, Stevens, Watson, and Wood, and four years later in a series of sessions of the Surgical Society of Paris by MM. Blot, Boinet, Bouvier, Broca, Depaul, Dolbeau, Follin, Giraldes, Hervez de

Chégoin, Le Fort, Marjolin, Trelat, Velpeau, and Verneuil.

In these discussions and in contemporaneous writings the supposed effects of muscular contraction received unwonted attention. The action of the powerful muscles of the hip seemed to threaten the integrity of the cartilages and bones composing the joint and to find in traction a worthy opponent. From these clinical premises, and too hastily, the conclusion was drawn that traction was curative because it saved the joint from being destroyed by the contracting muscles. The advocacy of this method by Drs. Davis, Sayre, and Fayette Taylor opened a field of observation and experiment which has been under ingenious cultivation ever since. An incomplete list of questions which have been answered in different ways includes the following: the question of separating the articular surfaces, of moderating articular pressure, of stretching the muscles until they were paralyzed, of keeping them stretched while motion was permitted in the joint, and the important but at first neglected question of fixation.

The hip splint was called by Europeans the American splint. As first described in 1860 it had two principal features: a perineal strap, or crutch-head, for receiving the weight of the body, and sticking plaster for making traction. The device by which the body is supported in the hip splint when the pa-

tient is erect cannot be said to have had its origin in America. But the other distinguishing feature of the splint, adhesive-plaster prehension, was an improvement rightly credited to American surgery. Thus the apparatus combined an old and a new device, the latter American, and, as the combination was made here, European writers courteously named the method and splint American.

Many changes have been proposed in the apparatus. In the "short hip splint" the upright extended only to the middle of the leg, and the patient's foot was allowed to rest on the ground. It was thought that when the instrument was keyed up the plaster would have sufficient strength and adhesiveness to resist the weight of the body and prevent it from making pressure on the joint. When this was found to be a vain hope, the apparatus was made to reach the ground and the weight of the body was transferred from the plasters to the ischium, practically producing a crutch applied under the leg instead of under the arm. Aside from this, no important change has been made. The splint has been modified experimentally for the enforcement of extension, abduction, motion without friction, relief from articular pressure, and counteraction of the circumarticular muscles. The attainment of these objects may or may not have been useful in certain stages. Experience has shown that certain

effects supposed to be produced were impossible, and others which might have been practicable were unnecessary. The value of the American method would perhaps have been more widely recognized even than it has been if too much had not been hoped from it. Traction simply stays the joint and relieves pain, and the perineal support effectively protects it from the traumatisms of standing and walking, while the patient runs about and follows the ordinary pursuits of his time of life for the months and years required to bring about recovery, with restoration of ability and symmetry, so far as may be.

BASIS OF TREATMENT BY THE SPLINT.

There are reasons for withholding assent from an opinion of the early advocates of this method, that traction owed its efficiency to its ability to overcome the muscles which were thought to be destroying the joint by their reflex contraction. This presupposed an inadmissible vicious circle, in which the destructive process excited muscular action, while muscular action aggravated the destructive process. According to one theory, the muscles should be stretched by the elastic power of India-rubber straps until they were paralyzed. This, however, was not likely to happen because opposition and exercise develop in-

stead of exhausting the power of muscular fibres, which would hardly surrender their supreme endowment of contractility to anything short of rupture or degeneration. If, on the other hand, the traction applied were inelastic and unyielding, the stretching which it could give to the muscles would soon have been arrested by the ligaments, and in any event it would have been insignificant in view of the elongation to which they had been accustomed in the alternations of contraction and relaxation. According to another theory the muscles might be kept from increasing joint pressure by a splint making traction and permitting motion of the joint at the same time; but insurmountable difficulty was found in trying to keep such a force in action through the variations and combinations of extension, flexion, abduction, and adduction. If, indeed, traction could have been applied directly to the bone without the intervention of the soft parts it possibly might have been in a position to counteract the muscles. It had to be applied, however, to the skin, which was but an elastic envelope of a mass composed largely of relaxed muscular and yielding connective tissue. These interesting speculations were prompted by what was believed to be a most important discovery. When traction was applied by a splint to a painful joint the appearance certainly was that of muscles subjected to counteraction, and when relief from pain immediately

followed, the inferences were natural that muscular action was a mischievous factor and that it was successfully overcome by traction. The enthusiasm excited by such signal relief, produced by means so simple, is reflected in the writings of those who first witnessed the seeming miracle.

The facts of morbid anatomy indicate that the destruction of the joint is not caused by muscular contraction. If it were, the evidences of friction would be seen in the acetabulum as well as on the head of the femur. In a large proportion of the tabulated cases, however, the acetabulum is unaffected. In the earliest incipiency of the disease the lesion (as is shown in Figs. 47, 48, and 49) is in the cancellous tissue, which is remote from possible injury. In a later stage, when ulceration appears, it is not on areas exposed to friction but chiefly on the neck of the femur, as in Figs. 50 and 51, and when the disease is in full possession it proceeds from within outward, as in Figs. 52, 53, and 54. It is not uncommon indeed to find specimens bearing evidences of direct injury, but as many patients are active on their feet without the protection afforded by apparatus, the destructive pressure is as likely to have come from weight as from muscular contraction. Fig. 55 shows a specimen after an operation in the third stage. In this case an unaffected area appears on the summit of the head, which is the part most likely to feel the in-

jurious effects supposed to be produced by muscular action. In this concise review, evidence has not been found of the destructive agency of the muscles.



FIG. 47.



FIG. 48.

FIGS. 47, 48.—Specimen from Boy Four Years Old. Duration of disease, four months. Death from tubercular meningitis. (Fricke, 1833.)



FIG. 49.



FIG. 50.

FIG. 49.—Exsection. Recovery. (Volkmann, 1879.)

FIG. 50.—Exsection. Girl eleven years old. Duration, two years. (T. Holmes, 1869.)

The diseased bones are highly vascular, and fragile to such a degree that an exploring needle has been used in diagnosis. They might well be expected to



FIG. 51.—Specimen from Boy Five Years Old. Duration, several months. Death from tubercular meningitis. (Barwell, 1881.)



FIG. 52.

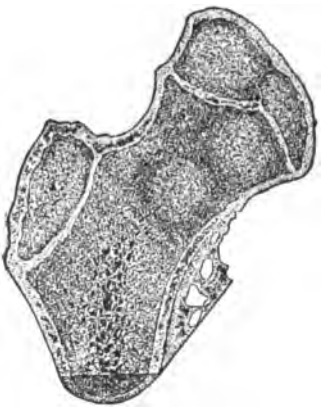


FIG. 53.

FIGS. 52, 53.—Boy, Eight Years Old. Duration, several years. Death from intercurrent disease. (V. P. Gibney, 1878.)

show the effects of severe pressure, since healthy vertebral tissue yields to the impact of an aortic aneurysm. If the force projected in the manner sup-

posed were such a menace as to require the exhibition of traction carried to the not uncommon measure of fifteen pounds, it should lead to perforation



FIG. 54.



FIG. 55.

FIG. 54.—Exsection. (Volkmann, 1879.)
FIG. 55.—Exsection. Recovery. Boy fourteen years old. (L. A. Sayre, 1876.)

of the floor of the acetabulum and invasion of the pelvic cavity by the decapitated femur.

Reasons for Applying Traction.—It is not necessary to go very far to find good and sufficient reason for this procedure. If traction secures fixation of a joint so intractable as the hip its application is amply justified. To immobilize the hip has always been a difficult problem. Mr. Charles Bell said: "No instrument has ever been effectual in keeping the thigh

and trunk fixed." Desault held the opinion that traction made by his long fracture apparatus immobilized all the joints from the hip to the tarsus. His splint consisted "in taking the points of extension above, on the tuberosity of the ischium and below on the malleoli; in securing the straps or rollers for making extension on the two ends of a strong splint placed along the outer side of the limb, and converting, so to speak, the pelvis, the thigh, the leg, and the foot into one entire and solid piece." Lesauvage wrote that one of the objects of continued extension in hip disease was to prevent motion. Mr. Liston, disparaging the weight-and-pulley experiments of Mr. Brodie, said: "All this may amuse the patient's mind, perhaps, but I do not think any good can come from it further than preventing motion." M. Philipeaux writes that traction may be employed to secure immobility of the limb. Dr. Fayette Taylor referred to "the quiet fixation of the joint which the splint has been a convenient means of accomplishing." Dr. Louis Bauer said: "Whatever benefit I have derived from it (extension) is unquestionably due to its fixing the affected articulation." Mr. Thomas wrote that extension involves unavoidably "a fractional degree of fixation." Dr. Yale writes: "When the muscular spasm is urgent, fixation cannot be secured, save by the use of force as constantly acting as that which is to be overcome, and the agent best adapted to this

purpose is traction." Dr. Wyeth writes: "Extension is made by means of the screw key, until there is freedom from pain and a comfortable fixation of the limb." Dr. Shaffer writes: "When traction exists the patient has the advantage of that peculiar and perfect immobility which the extension of the long hip splint affords."

Function of the Muscles.—The muscles have a twofold function: they move the joint and they fix the joint. If their action is at a point remote from the centre of gravity of the body, they are more effective in both motion and fixation because of the disproportion between the part above and that below the point of motion. There was philosophy, as well as humor, in Dundreary's witticism: "Why does a dog waggle his tail? Because the tail can't waggle the dog." This action is not only motion, but also arrest of motion, right and left. It follows that if the part below is more easily moved on account of its comparative lightness, it is also more easily fixed for the same reason. This makes joint disease less serious the nearer it is to the distal phalanges. Aside from the instability of the ball and socket at the hip, if the whole limb were no heavier than the foot hip disease would not be more serious than ankle disease. Mr. Hilton related a case in which the patient, who had hip disease and white swelling of the knee of the same limb, recovered rapidly from the former after amputation

above the knee. His comment was: "In fact, I may say that the hip joint was cured by cutting off the leg."

It may also be borne in mind that the hip is peculiarly disturbed by the movements of other joints. In the words of Charles Bell: "There is no rest to it; every motion of the body may be said to be accompanied with a movement of the head of the femur within its socket; even if the arm be raised, there is a change in the centre of gravity of the body, and the trunk must be poised anew upon the hip, as the centre of all our motions. It is remarkable how the slightest degree of movement in another part of the body is, as it were, necessarily accompanied with a motion of the surfaces of those bones which compose the hip-joint. If ever you should see a patient suffering with acute inflammation of the hip, you will see the proof of this; for every motion of the body gives extreme pain, and proves an additional source of excitement and inflammation. It is this consideration which leads us to understand the difficulty of curing the disease."

A retentive splint, so useful in the surgery of fractures, is at a disadvantage when applied to the hip on account of the short lever above the seat of motion, extending only from the acetabulum to the crest of the ilium. If it were equal to that below, or if the pelvis and vertebræ were replaced by a long bone,

retention would be as easy as at the knee. In like manner the treatment of Colles' fracture of the wrist may be simplified in the imagination by fusing into one piece the parts of the skeleton below the fracture. A toy cup and ball furnishes an illustration. The long handle of the cup gives more than enough leverage, but a retentive contrivance would fail unless additional leverage were given to the ball by driving a stick into it to serve as a handle or lever.

Correlation of Traction and Fixation.—In the presence of the mechanical difficulties which hamper fixation of the hip-joint by retentive means, hopeful resort may be had to traction. Simple *Retention*, however, has been applied to the hip, and with considerable success, notwithstanding its disadvantage of short leverage. This is true especially in the use of the splint invented by Mr. Thomas. Other examples are also found. Dr. Coates, referring to Dr. Physick's hollow carved wooden splint, which extended from the malleoli to the middle of the thorax and included one-half of the trunk, wrote: "The patient frequently stated that he had obtained in the night following its application sounder sleep than for many weeks, or even months, previously." M. Bonnet wrote: "I have seen the pain and inflammation disappear as soon as the limb was brought into position and held immovable" by *le grand appareil*, which included two-thirds of the circumference of the lower

limbs and trunk. "From the moment of application the pains diminished." M. Philipeaux, relating his experience with the same apparatus wrote: "The next morning I learned that the patient, who had moaned incessantly the night preceding the application, had slept calmly for four hours." Mr. Noble Smith, referring to Mr. Chance's splint, which included the thigh and a large part of the trunk, speaks of "the almost immediate relief from pain which the patient experiences when the splint is applied." On the other hand a number of instances may be cited of the remarkable relief from pain produced by *Traction.* It was observed by M. Blandin that, on the application of extension and traction, the acute pains of hip disease "disappeared as if by enchantment." Mr. Brodie described a weight and pulley applied "in line with the thigh bone" and added: "It is astonishing what comfort I have known this to give the patient." Gustav Ross wrote that when the weight and pulley were used in the hip disease of children "the pain lessens astonishingly." Dr. Watson, of the New York Hospital, relating a case of acute hip disease when the new method of treatment was discussed by the Academy of Medicine, said: "I had hardly put on the counter-extension before the girl was entirely free from pain. It operated beautifully and instantly." Dr. E. S. Cooper, of California, describing an ingenious device for traction, wrote:

"Often have patients slept better the first night after its application than they had for many months previously." When pain is thus seen to be controlled equally by tractive and retentive apparatus, the correlation of traction and retention is evident.

Character of the Pain.—It has been thought that relief follows too promptly to be rightly considered as the result of purely mechanical interference. It may be said, however, that the pain of hip disease is composed largely of apprehension and fatigue, both mental and muscular, attending prolonged voluntary and reflex efforts to prevent motion, with sharp accessions when motion is made inadvertently, or as the patient starts when falling to sleep. Such pain is instantly relieved and prevented by whatever pro-

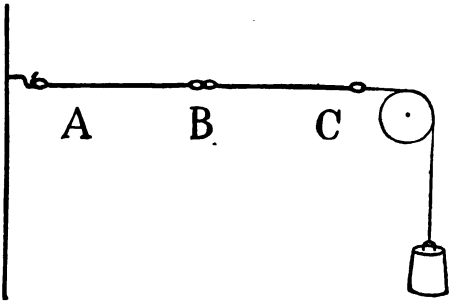


FIG. 56.—Fixation by Weight and Pulley.

tects the joint from disturbance. In some cases severe pain, not controlled mechanically, probably indicates a collection of matter in the bony cells.

That traction secures fixation is capable of demon-

stration. Take two iron rods, *A B* and *B C* in Fig. 56, resembling two links of a surveyor's chain. If the free end of one is attached to a wall while traction is applied by a weight and pulley to the free end of the other, mobility is seen to be absent from their joint so long as adequate traction is maintained. This explains the action of "Buck's extension" in fractures. To say that traction stretches the muscles until they act directly as retentive splints overlooks the lengthening which belongs to them in customary relaxation. The fixation thus produced in the two links of chain by a weight and pulley may readily be disturbed by a competent force, but if a tractive splint be substituted for a weight and pulley the result is remarkably firm and indestructible.

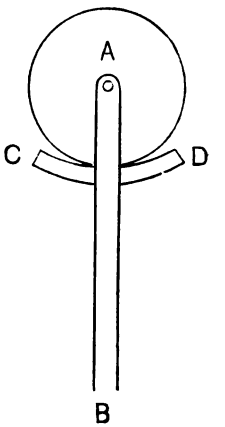


FIG. 57.—A Mechanical Brake (1883).

When the splint is applied to a patient fixation is promoted also by the action of what is known in mechanics as a brake. The perineal strap retards motion by making friction on the region to which it is applied. In Fig. 57 the circle represents the pelvis, the point *A* the joint, *A B* the femur coalescing with the upright of the splint, and *C D* the strap, practically of one piece with *A B* applied to the ischium.

When traction is enforced by the rack and pinion, motion at *A* is retarded by friction. The splint also acts, although at a disadvantage, as a retentive apparatus, being assisted in this function by restraints applied above the knee, which limit motion at the knee and promote coalition of the thigh and the upright.

Paradox in the Treatment of Joint Disease and Fracture.—The idea that hip disease and fracture of the femur require similar treatment is not very new in medical literature. In 1779 David de Rouen wrote that "notable cures of disease of the joints are to be effected by allowing the parts to remain undisturbed in splints, as in the treatment of fractures." M. Bonnet presented *le grand appareil* for hip disease in 1845, after having described it in 1839 as a fracture apparatus, and the complicated method of M. Martin was prescribed in 1850 for fracture and in 1865 for coxalgia. Mr. Ford (1810) compared hip disease without sinuses to a simple fracture, and Mr. Brodie made this comment: "If the cartilage be extensively destroyed without suppuration, the case may be compared to one of simple fracture; and if there be suppuration, it may be compared to one of compound fracture, a statement which led Dr. March to ask (1853): "If there be some analogy between the condition of the hip-joint in morbus coxarius and fracture of the neck of the bone, why should there not be some similarity in the mode of treatment?" As

if to enforce his view, he invented, and described with a cut, a hip splint which resembled in its action the long fracture apparatus of Desault. There is an obvious incongruity in the proposition that the same treatment is applicable in an emergency in which arrest of motion is essential to recovery, and in an affection in which mobility is earnestly desired. An escape from this predicament lies in accepting the proposition that when a joint is inflamed ultimate mobility is to be sought by arresting motion and thus minimizing the products of inflammation.

DETAILS OF TREATMENT BY THE SPLINT.

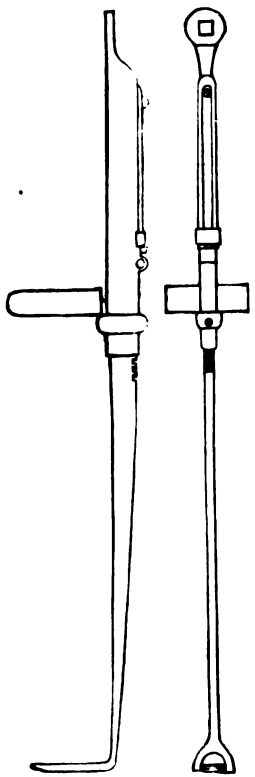
The upright of the hip spint is usually made round in shape, as is shown in Figs. 58 and 61. The splint shown in Figs. 59 and 60 is flat, the metal being disposed in the direction of the strain. The lateral



FIG. 58.—Round Hip Splint and Knee-piece (1880).

strain falls with exceptional severity on the splint when two perineal straps are in use. But with a single strap, the weight falls almost vertically on the upright, and a lateral distribution of the metal is unnec-

essary. The splint may then be made from steel tubing as seen in Fig. 61, a number of bars of vari-





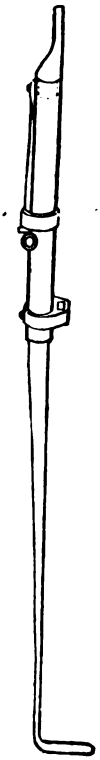


FIG. 59. FIG. 60. FIG. 61.

FIG. 59.—Flat Hip Splint (1885). FIG. 60.—Flat Hip Splint Complete.
FIG. 61.—Steel Tube Splint (1903).

ous lengths being made for each barrel to meet the requirements of longer and shorter limbs. Some advantage is gained by giving the length to the bar

rather than to the barrel, an arrangement seen in Figs. 59, 60, and 61, which brings the key and the bulk and weight of the apparatus near the body, where they are more conveniently managed than when near the foot. The splint shown in Fig. 60 weighs from two pounds to four pounds and eight ounces. The different parts of the splint and their uses are well known. The knee piece is of soft metal for bending to fit the limb and is adjustable vertically on the upright. It limits motion at the knee and, *pari passu*, at the hip. The pelvic band is a nearly semicircular bar of inflexible steel, adjustable at the selected angle, usually a right angle, where it is immovably fixed by a bolt and nut. If extreme flexion is present this band should take a marked angle. The screw holes at its ends are "upset" on the inner side before the band is covered with Vulcanized rubber, or wound with adhesive plaster to prevent rust, and Canton flannel or silk cut bias in strips. The perineal strap is of webbing, doubled for a heavy patient, softened with some woollen stuff, and covered with Canton flannel. It may be washed and has a loop for buttoning on the ends of the pelvic band over the screw heads.

Key to the Application.—The determination of the length of the strap is the key to the successful use of the splint. If the perineal strap is too long it allows

the pelvic band, when weight is thrown on the splint, to rise to such a level as to abrade the skin covering the anterior superior spinous process of the ilium, the level of which is indicated by the transverse line drawn in Fig. 63. If, on the other hand, the perineal strap is too short, it holds the band down where it makes intolerable pressure on the pubic crest. It would seem that a transverse depression had been provided between these two levels, in which pressure is harmlessly received by the abdominal wall. It is well to ascertain by experiment the right length of the strap, and then to attach it by loops, instead of by buckles which permit careless adjustment. If the strap is a simple ischiatic support it may be left on the band and the apparatus may be pulled on over the foot. A band which is held at a low level on the pelvis by a short strap implies a short, light, and convenient upright, and the band can be smaller than it would have to be if worn with a long strap at the level of the iliac crest or ribs. Another advantage will appear in the fact that a band thus kept in its proper place will be below a

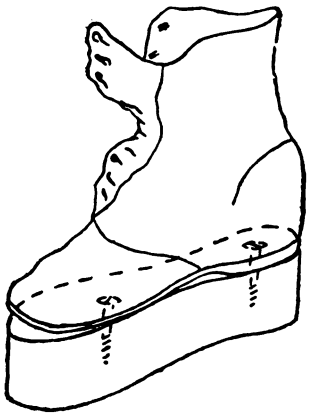


FIG. 62.—Wooden High Sole.

spinal brace or plaster jacket if concurrent disease of the spine requires treatment.



FIG. 63.



FIG. 64.

FIGS. 63, 64.—Splint Applied for Protection, Weight of Body Thrown Alternately on the Splint and on the Well Foot, Carrying Strap Relaxed and Tense. Pelvic band kept below level of iliac spine by short seat strap.

To Give Protection the upright should be of such a length as to keep the heel, but not necessarily

the toe, clear of the ground. Concussion passes from the heel directly to the diseased joint, but from the toe indirectly, and softened by the elastic action of the muscles moving the tendo Achillis. A carrying strap (seen in Figs. 63 and 64) is made from a piece of wide webbing which passes under the head of the upright and crosses the opposite shoulder to buckle in front at the convenience of the patient. As the splint extends quite a distance below the foot, the well foot will have a high sole, a convenient form of which is seen in Fig. 62. Thus protected, the affected limb is a pendent member, the perineal strap being practically a crutchhead. Dr. Fayette Taylor wrote that "the patient sits firmly upon the padded strap." Dividing his weight between the sound limb and the splint, he doubtless has a composite



FIG. 65.—Splint Applied for Traction.

sensation of standing and sitting. In progression weight is thrown alternately on the splint, as in Fig. 63, and on the well foot, as in Fig. 64. It is not entirely fanciful to say that the patient is sitting while walking. It is related that a little boy, to whom the splint was applied, walked about exclaiming: "I'm sitting down." When tired a patient may lean against some support and rest by sitting on the strap. Mr.

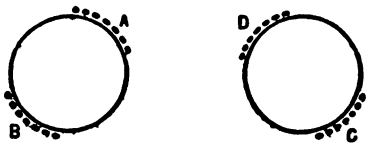


FIG. 66.—Application of Adhesive Plaster to Limb (1887).

Adams, returning to London in 1877, described children under treatment for hip disease walking about the streets and "enabled to get in and out of the tramway cars without difficulty."

To Make Traction, strips of adhesive plaster may be attached to opposite sides of the limb and protected by a reversed bandage. Drawing the turns of a roller and passing it under the limb are painful to a sensitive joint, from the necessity of raising the limb. This difficulty was overcome in Dr. Fayette Taylor's practice by the use of a legging of twilled muslin, seen in Fig. 65. It was slipped into place and laced without disturbing the limb. Dermatitis may appear under the plaster as the result of retained moisture, as it does under a continued poul-

tice. It is said that a "wet pack" is sometimes artfully claimed to have a curative effect on rheumatism and other complaints by drawing morbid matter to the surface in the shape of an eruption. The skin will escape irritation if one strip is applied antero-laterally, as at *A* in Fig. 66, and the other postero-laterally, as at *B*, leaving fresh areas for the reception of succeeding strips at *C* and *D*.

When prehension of the limb is thus secured the leather straps seen in Figs. 60 and 65 may be buckled to the plasters and the ischiatic strap adjusted on the pelvic band. Traction may then be made by propelling the rack with the pinion. If a high degree of traction is employed in warm weather, or in a hot room, the plaster will gradually slip down, when the leather straps may be buckled shorter and the plasters renewed sooner. Their removal may be facilitated with naphtha or some other solvent. A light plaster may be reënforced, before the buckles are stitched or eyeletted in place, by tape sewn on in parallel lines which will not prevent the removal of the facing just before application. Gum collecting on the needle of the machine may require a drop of oil.

Traction is especially applicable to the victim of an advanced stage. Mr. Hancock's description included these words: "Look at a patient wasted to a shadow, confined to his bed for months and in the

last stage of exhaustion from long-continued discharge, his hands employed night and day incessantly maintaining a fixed position of the limb, and endeavoring to prevent the intense agony which occurs on the slightest movement. Often have I seen the poor hip-joint patient, when all others have slept, still wakeful and anxiously engrossed with the one and monotonous task of steadying the knee and preventing movement." This graphic description was written in advocacy of exsection of the hip, an operation of heroic surgery, described by a fanciful writer as "majestic and sanguinary." Continuing his argument Mr. Hancock proceeds: "Look again at this patient; his position is no longer one of constraint and torture, it is one of comparative comfort and rest. He no longer suffers the extreme pain, he no longer exists in dread of the slightest movement or jar, his countenance loses its drawn and anxious appearance, the hectic subsides and we have alleviated a very vast amount of suffering almost beyond the power of endurance." Mr. Hancock's description of the change wrought by exsection applies with exactness to that effected by traction or fixation.

Details of Application in the Third Stage.—In this stage treatment may be promptly undertaken regardless of the presence of abscesses, sinuses, or extreme deformity. The splint, being designed for a normal figure, throws the deformity into such marked relief

that it seems impossible at the first view to proceed. With the upright of the splint lying against the extremely adducted thigh, the pelvic band will necessarily extend obliquely across the recumbent trunk in front and behind. It will therefore be desirable to begin by using a perineal strap the length of which can be varied by attaching it by buckles screwed to the pelvic band. The strap will then be far from occupying the position directly under the ischiatic tuberosity which it would take if the limbs were symmetrically disposed. It may even be applied at first to the unaffected side of the perineum. Thus, proceeding slowly and with care, the instrument may be so arranged as to permit the employment of a slight amount of traction and counter-traction by the use of the key. This is at once attended by a partial and agreeable arrest of motion, followed immediately by commencing reduction of deformity. In a few days, or in a few hours, with freedom from pain and with returning sleep and appetite, and with fresh hope and confidence on the part of the patient, the case will be more easily managed. In a short time symmetry will be found to be so nearly restored that the pelvic band will cross the body transversely and the splint can be conveniently worn. The buckles may then be removed and the long strap may be discarded in favor of a suitably short one provided with loops for buttoning over the ends of the pelvic

band, which will thus be brought down to its proper position below the level of the iliac spinous processes. Flexion and adduction will have been seen to diminish, the latter very likely giving way to abduction to such a degree as to cause anxiety from extreme apparent lengthening. This will in its turn diminish with the resumption of locomotion.

Weight and Pulley.—The pain which attends this difficult stage calls for treatment with the least possible delay. While the splint is being prepared a weight and pulley may be applied. If the pulley is attached to the wall of the room at a considerable height, the direction which the traction takes may be changed, with great convenience and without disturbing the patient, by rolling the cot toward or away from the wall or to one side or the other of the pulley. When deformity has been partly reduced by the weight and pulley, treatment may be continued by the application of the splint. A vast amount of care and consideration may well be exhibited in the management of a case of this kind until the patient learns the use of the key, when happiness and contentment take the place of misery of an extreme type. Many years ago when mechanical treatment of this disease was under consideration in a children's ward at Bellevue Hospital, there were more hip cases than splints, and it was necessary to shift apparatus from less to more painful cases,

which was always done with difficulty and as a cruel necessity, for the youngsters had learned to appreciate the comfort and convenience conferred by the new treatment.

The patient in an advanced stage, and indeed in any stage, should have a liberal and varied diet. He will soon leave his bed and join his playmates. He becomes an office patient or, if treated at a hospital, an out-patient. Being equipped for painless locomotion, he is instructed in the acquisition of a symmetrical gait characterized by normal rhythm in his footsteps. As he gathers strength and marches in military time it becomes evident that fixation is sufficient to save the joint from pain and to promote repair, but not so rigid as to check restoration of shape by the unconscious efforts of the patient to give to the limb an attitude convenient for locomotion. There will be days when the child will be overcome by lassitude, and nights of disturbed rest. Such interruptions, probably requiring medication, will diminish in length and frequency with the approach of recovery.

The relaxation of the leather straps, which is observed when the patient throws his weight on the splint, has the appearance of being a failure in the action of the apparatus. It is caused in various ways. It may be the result of making the whole splint so light that it bends under the weight, enough perhaps

to allow the patient's heel to rest on the foot-piece of the splint. It may also be caused by wearing the pelvic band too high, as shown in Fig. 67, where the curved line and the dotted line represent the perineal strap before and after the weight of the body falls on it, causing a descent from *B* to *D* and a corresponding slackening of the leather straps. Fig. 68 shows a comparatively slight descent from *B* to *D* effected

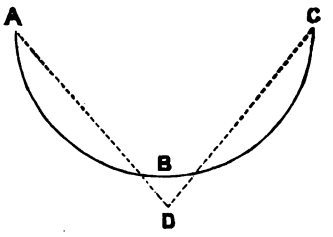


FIG. 67.

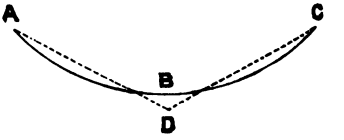


FIG. 68.

FIGS. 67, 68.—The Effect of a Long and of a Short Strap (1881).

by lowering the band and shortening the strap. It has been suggested that in walking the limb is subjected to alternate traction and relaxation, and that the joint is thus exposed to a pumping process. It may be borne in mind, however, that the traction made by the use of the key when the patient is recumbent seldom equals that made by the weight of the limb when the patient is erect. It is probable, therefore, that the joint can be pumped only by alternations of standing and recumbency.

The Management of the Apparatus at Home may be governed by two rules, one of which calls for per-

sistent separation of the heel from the ground, regardless of the tension or relaxation of straps when the patient is up, while the other prescribes that the straps shall automatically become tense when he lies down. The patient, if past the age of infancy, assumes control of the key himself, and he soon learns that the observance of the prescribed details secures convenience and freedom from pain. The splint thus applied is worn day and night, providing (1) for general health by exchanging the sick-room for out-of-door activity, (2) for arrest of motion in acute stages, (3) for removal of weight from the joint in all stages, and (4) for locomotion with the limb in good position. In a favorable case a patient may be said to walk toward recovery *cito*, *tuto*, *et jucunde*.

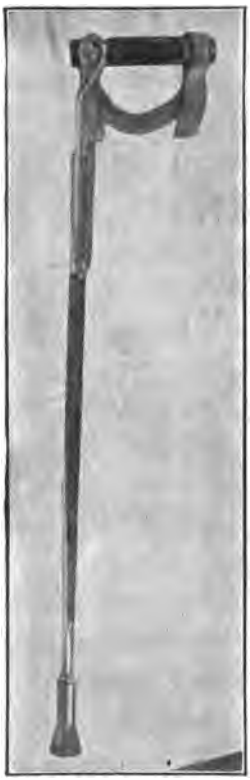


FIG. 69.—Ischiatic Crutch. Seen also in Figs. 63 and 64 on p. 111 (1887).

Traction to be Withdrawn. The Ischiatic Crutch.—When it is seen that the patient is indifferent to the use of the key it is a clear indication that he has

passed out of the acute stage in which traction was necessary and that the joint is tolerating motion and disturbance. The plasters may, however, remain on the limb and the splint may still be worn at night for a few weeks or until continued neglect of the use of the key makes it evident that traction, agreeable at first on account of its anodyne quality, has ceased to be desirable and useful and is not likely to be again required. The leather straps and the plasters to which they buckle may then be removed and the apparatus may be laid aside at night. It is then useful only as a protective splint and in due time it may be replaced by a simpler instrument capable of being lengthened as the patient grows by the overlapping parts seen in Fig. 69. A joint is sometimes introduced in this splint at the level of the knee. A release provides for flexion at will and firm extension is made automatically. With the adhesive plasters and rack and pinion discarded, the upright may be shod with sole leather, in the manner seen in Fig. 70, or with any of the ordinary forms of crutch tip, one of which is seen in Figs. 64 and 69. It is then practically a crutch, weighing from one pound and eight ounces to three pounds and eight ounces. In other respects the instrument is unchanged in its application and adjustment. It

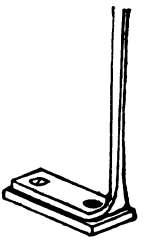


FIG. 70.—Splint Shod with Sole Leather (1887).

is worn only when the patient is out of bed, as in disease of the knee or ankle, or in any chronic ailment in which one limb requires protection from the weight of the body.

Comparative Importance of Traction and Protection.—It is an interesting question whether traction or protection is the more important feature of mechanical treatment. If the morbid foci were recognizable at their very beginning, protection, by converting the limb into a pendent member, might lead to resolution with no further trouble and traction might seldom be called for. But the diagnosis is almost never made until painful symptoms demand traction, which is then extremely important as a means of relieving pain and promoting resolution by arrest of motion. It is required, however, but a comparatively short time in the long duration of a case. Protection, on the other hand, is necessary from the beginning to the end of the treatment. It is more indispensable than traction, since it provides for locomotion and ultimate symmetry and promotes resolution by arresting the most mischievous function of the joint, weight-bearing.

While it would be difficult to treat urgent cases without resorting to fixation, the hope may be indulged that the application of traction, or of any other form of fixation, will in time become unnecessary or unusual when improved methods of early

diagnosis shall have made it possible to induce resolution in the initial stage by the timely enforcement of protection.

The significance of the **Weight of the Body as a Factor** in joint disease is established by a review of certain figures drawn from the reports of two orthopædic institutions for a given year, in which many more patients were treated for disease in the lower than in the upper extremity. The table follows:

Lower Extremity.		Upper Extremity.	
Hip	558	Shoulder	7
Knee	207	Elbow	16
Ankle	64	Wrist	3
Total	829	Total	26

At the first glance, it would seem that joint disease is caused by the pressure and concussion which fall to the lot of the lower extremities, but this view is not in accord with the indications of typical histories, which include tuberculous deposits in the cancellous tissue, which of course may occur in any part of the skeleton. The correct inference is that foci in the upper extremity, where they are exempt from violence, undergo resolution without symptoms or recognition. This agrees with the fact that the dreaded tuberculous process, wherever it appears, owes its destructive quality to unfavorable environment, mechanical and otherwise, and not to an inexorable disposition of its own. Quiet resolution may hardly be

expected in the lower extremity which feels the pressure of the weight of the body and the violence attending locomotion, violence of great severity when the bones are called to withstand the successive blows which attend running and jumping.

Disease of the Wrist, Elbow, and Shoulder.—When, as sometimes happens of course, tuberculosis of the joints assumes destructive activity in the upper extremity it may be owing to the absence of desirable arrest of motion, and in some cases perhaps to passive motion, or *brisement forcé*, prescribed for the prevention of ankylosis. Fixation may readily be made at the wrist by a plaster-of-Paris dressing or a simple supporting and restraining splint, on which the hand and forearm are confined by strips of adhesive plaster, leaving the digits free. Such an application restored the right wrist of a boy nine years old who was under treatment for purulent right hip disease, a sinus appearing on the palmar surface of the wrist in December, 1890, about six months after one developed at the hip. There was disintegration of each joint with profuse and at times offensive discharge. The sinus at the wrist permanently closed in August, 1892, one year after closure at the hip. In 1904 limitation of motion at the wrist was found only after careful comparison with the other wrist. If ankylosis at the elbow is unavoidable, it should be at an angle giving the best ultimate convenience in the use of

the hand. A retentive splint at this point should give exact control. But a splint applied to control motion between the humerus and scapula will meet with the difficulty which is present at the hip-joint, absence of efficient leverage above the point of motion. The ordinary methods of averting accidental disturbance of this joint and preventing undue use of the arm seem to afford sufficient fixation. Loss of motion is concealed even more readily at the shoulder than it is at the hip, where vicarious mobility, in the spine and the other hip-joint, gives remarkable facility in the use of the limb. The scapula is so loosely attached to the trunk that its joint with the humerus may be ankylosed with the retention of very wide use of the arm. In his paper on "Quiet Necrosis" Mr. Paget wrote as follows: "The most remarkable case was a boy of whom, though he had been carefully brought up, it was never known that his left shoulder was completely stiff till he went to Eton and was found defective in some of the school games. The joint was immovable, the muscles around it wasted, but it was free from all signs of disease, and I fully believe always had been so; and, whatever had been the disease, it was now passed." The same good result follows intelligent expectation in cases of purulent disease of the shoulder-joint.

Methods of Protection.—In joint diseases of the lower extremities the ever ready recumbent position

of course gives perfect protection from the traumatisms inseparable from locomotion. Protection is also furnished by horseback and bicycle riding, either of which may be prescribed or allowed in suitable cases. For the very young the tricycle may be substituted for the more difficult machine. A more common resort is to a pair of crutches, the usefulness of which may be increased by the addition of a high sole to the well foot. Experiments are on record in which a high sole was added to the well side and a leaden sole was attached to the shoe of the affected limb for the purpose of increasing the traction which is naturally made by the weight of the limb when the patient is erect. Dr. Norman Chapman advocated protection of the diseased hip by flexion of the knee in a silicate bandage in order to keep the foot from the ground. Mr. Brodie said: "The patient should never walk except with the assistance of a crutch," a precept that has been little regarded, crutches being usually considered not as a curative device but rather as aids to locomotion, or as insignia of the crippled condition. The older surgical works contain cuts of an ordinary crutch with a horn, or curved process, at a suitable level for receiving the ischium or the upper part of the femoral shaft. An artificial limb often receives weight in the former region. Hip splints furnishing ischiatic support were described by Italian surgeons, and one carrying two perineal straps was

figured in a surgical work published at Paris in 1853. Dr. Edmund Andrews was not unmindful of the superiority of ischiatic over axillary support in cases of chronic disease of the lower extremity. The instrument invented by him is represented in Fig. 71. Dr. Prince described a brace to which he gave the name of ischiatic crutch in 1866. An inexpensive form of Dr. Prince's splint is seen in Fig. 72. The well-known "Dow" of Dr. Taylor has a convenient joint at the level of the knee. Axillary supports are conspicuous and easily forgotten or wilfully laid aside, while the ischiatic crutch cannot be readily taken off, leaves the hands and arms free, and is almost invisible under the clothing. The weight of the body supported in this way is felt, not in the unstable and sensitive axillæ, but on a solid and basilar part of the skeleton, which is accustomed to weight bearing in sitting and walking. The ischiatic crutch seen in Fig. 63 has been used with convenience as an artificial limb in a case in which cosmetic considerations

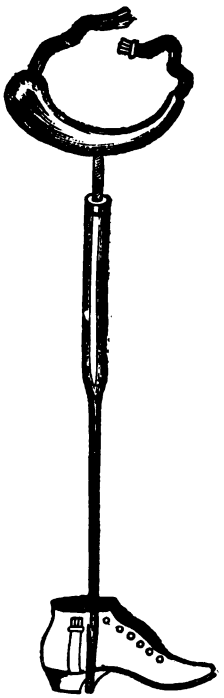


FIG. 71.—Dr. Andrews' Splint (1860).

were negligible. The ease with which it could be lengthened made it especially suitable for a growing child. It requires considerable time for a patient to learn to walk conveniently with this apparatus and for the perineum to tolerate the presence of the seat strap. Otherwise it would probably be frequently used in fractures and other acute cases requiring arrest of the function of one limb.

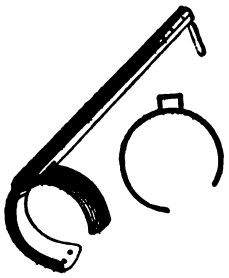


FIG. 72.—Dr. Prince's "Ischiatic Crutch" (1866).

Ununited Fracture, with its tedious duration, presents an emergency in which this instrument has been useful. This trouble seems to come to an end when the patient, unwittingly or by advice, exposes the fragments to irritation caused by the use of the limb imperfectly protected from the corporal weight. The ease with which the amount of irritation may be varied by lengthening or shortening the splint suggests this as a practicable resort.

Discontinuing the Treatment of hip disease is a matter requiring the exercise of judgment and caution. It is of course better to continue treatment longer than is necessary than to desert the vantage-ground of protection too soon. The patient has become so accustomed to the splint, and has had so little inconvenience from its habitual use, that he is usually in no

haste to part with it. After a long course of protection, and when the sinuses, if any have appeared, have been replaced by firm scars, the patient may be encouraged to go without the steel crutch every day for a short time, which may be lengthened under judicious advice. Later the splint may be removed in the house, and reapplied when the patient goes out. Still later, he may be out of doors without the splint for a while each day, and then without it all day once or twice a week, and finally it may be laid aside entirely. A return to ischiatic support in waking hours should at once follow a recurrence of symptoms. While gradual release from treatment is in progress, the patient should be observed and advised from time to time until the joint is well. In exceptional cases, due to recurrence of disease or to mistaken judgment, there should be resumption of treatment with as much zeal and confidence as if the affection were beginning. After recovery, the patient should avoid extreme exertion, such as mountain climbing, tramping with a gun, and long pedestrian tours. An example of the bad effects of undue physical effort is seen in Case XI. recorded on pages 152–154. It is a strange fact that many young people with more or less locomotor disability feel impelled to accept undertakings involving extraordinary endurance and physical exertion. Their unreasonable ambition in this direction should be checked.

CHAPTER VI.

ABSCESSES OF HIP DISEASE.

In many cases the course of hip disease is diversified by the appearance of sinuses, some of them the result of spontaneous eruption and others established by operations on swellings or diseased bone. It is not easy to draw a line between cases which have and those which do not have abscesses. Collections supposed to be purulent may happily disappear. Operations on bone sometimes leave sinuses with an indefinite flow in cases which would have shown no discharge if the knife had been withheld. Such instances may or may not be included in a compiled table of cases attended by abscesss. It is therefore difficult to say what percentage of patients have this complication. Is it an abscess when the fluid is confined in the cancellous tissue or in the cavity of the joint, or only when it gathers enough volume to return fluctuation, or only when it appears on the surface? These questions would be more significant if abscesses were more important features of joint disease than they are.

When abscesses appear as tumors, and especially

when they discharge, they are much dreaded in the popular mind, but in practice the management of the affected bone in which they rise claims chief attention. They show caprice in their early or late appearance, their number, their location, and in their deportment.

COLD ABSCESSES.

CASE VI.—*Cold Abscess.*—A girl seven years old, when first seen in December, 1881, had suffered from disease of the right hip for one year. Nine months later a fluctuating tumor appeared without interference with health and activity. In two months, having reached a great size, it opened on the anterior and upper part of the thigh when she was sweeping the sidewalk with a toy broom. There was a torrent of fluid containing flakes of caseous matter. Collapse of the tumor was followed by a varying discharge for seven months, which ceased with the formation of a scar. Seven months later moisture reappeared, and for eighteen months there was a succession of small scabs followed by a scar which, in 1898, was attached to the bone. This abscess was attended by no general disturbance, and caused no pain or loss of blood. Other cases followed a similar course.

In 1879 a girl of the same age had a large collection of matter on the inner side of the thigh present-

ing at its summit a small area of insensible skin which she broke with a pin, while playing in the gutter. Fluid escaped in a jet followed by collapse of the tumor and the formation of a scar five months later, which in 1885 was depressed and attached to the bone.

A boy five years old, in 1883, presented a fluctuating tumor extending from the trochanter to one inch above the patella, which opened during sleep. He thought he had wet the bed. The sinus alternated between eruption and closure for five and one-half years, leaving a scar which was firm and bleached in 1898. The position of the limb in this case is described on page 179.

CASE VII.—*Cold Abscess.*—A girl four years old, when first seen in October, 1883, had suffered from symptoms of disease of the left hip for several weeks. The usual signs of the disease were present except that measurements failed to reveal wasting of the limb, the thighs being equal in circumference. Fifteen months later fluctuation was found by palpation, extending downward two inches and a half from the trochanter, and the measurements were as follows: Left upper thigh, 12¾ inches; lower thigh, 8½ inches; leg, 8⅛ inches. Right upper thigh, 12½ inches; lower thigh, 9⅜ inches; leg, 8⅜ inches. At this stage the affected thigh often measures between one and two inches less than the well one. Its size

in this case was maintained by the presence of a deep collection of fluid. Fluctuation slowly disappeared and although the limb slightly increased in size with the growth of the child, it failed to keep up with the well limb. At a later date the measurements were: Left upper thigh, 13¾ inches; lower thigh, 9½ inches; leg, 9½ inches. Right upper thigh, 15¼ inches; lower thigh, 11¼ inches; leg, 9¾ inches. Treatment ceased in March, 1888. There were no other abscesses. The patient recovered and was last seen in September, 1890.

In a similar case a girl three years old presented in 1887 a fluctuating tumor on the anterior and outer side of the thigh at the junction of its middle and upper thirds. It reddened and pointed, and an eruption was predicted. The tumor decreased, however, and was gone six months after its appearance, leaving a dimple, seen in 1893, twenty months after treatment had ceased. The pit was evidently caused by the entanglement of fasciæ in deep scar tissue. It was depressed as the child gained in flesh. Occasionally a patient receives a scar without the appearance of a trace of moisture or fluid. A wide area of skin covering a fluctuating tumor becomes indurated and thick. At one point it thickens more and more until a substantial and prominent scab forms. Fluctuation slowly disappears and a depressed scar is left resembling that which follows ordinary spontaneous

eruption. In all these cases it was not difficult to take an expectant attitude, which was justified by the results. The matter made a harmless exit or disappearance. Such a collection adds nothing to the duration of the disease and compromises the result in no way. The diseased bone recovers, unmindful of the deportment of the soft parts. Unfortunately, very few of the abscesses of hip disease act in this way. They are often attended by pain and general disturbance.

INFLAMED ABSCESSES.

CASE VIII.—*Cold, followed by Inflamed, Abscess.*—A boy four years old, when first seen in November, 1879, had suffered from disease of the right hip for one year. Fifteen months later a cold abscess appeared and grew until it occupied the upper two-thirds of the outer side of the thigh, distending the boy's trousers. It decreased and could not be found twenty-one months after its appearance. The tissues were condensed and three months later, without a return of fluctuation, a sinus opened on the outer side of the thigh with pain and general reaction. Alternations of eruption and quiescence were observed for several years, but without interference with the patient's activity, until the case was lost to observation.

Abscesses were attended by severe local and gen-

eral symptoms in the case of a boy seven years old. The first one was incised on the inner side of the thigh in January, 1875, and was followed by three

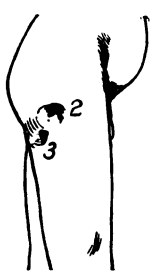


FIG. 73.

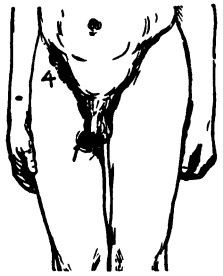


FIG. 74.

FIGS. 73, 74.—Place and Order of Sinuses in Case XIII. (p. 158).

sinuses on the outer surface and in the groin. Their places and order of appearance are shown in Figs. 73 and 74. The swellings were hot and painful and oc-



FIG. 75.

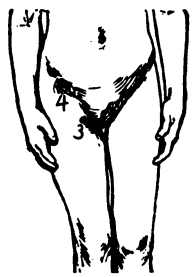


FIG. 76.

FIGS. 75, 76.—Place and Order of Sinuses in Case XII. (p. 154).

cupied wide areas of infiltrated tissue. When at their worst they caused distress and debility, with hectic, febrile temperature, failure of appetite, dis-

turbed sleep, and wasting. At such times the boy, up and dressed daily, moved about with crutches and a splint with which he maintained comfortable traction. In the intervals he discarded crutches and was out of doors. After two years the sinuses permanently closed leaving scars, which twenty-four years later were found attached to the bone (CASE XIII., p. 158). A group of abscesses similar in character and effect appeared in the thigh and groin in the case of a girl three years old, as seen in Figs. 75 and 76. They complicated the progress of the disease from March, 1878, to September, 1879, as is recorded in Case XII. (pp. 154, 157, and 158).

CASE IX.—*Inflamed Abscesses.*—A girl seven years old, when first seen in January, 1883, had suffered from disease of the left hip for three years. A sinus following an incision had been open on the anterior and upper part of the thigh for five months. Six months later it closed with a firm scar. At the end of two years and three months it reopened and closed again after a few months. This was repeated three times between October, 1885, and August, 1895. On each occasion the gathering was marked by local distress and febrile prostration. Fragments of bone were found in the matter. In the intervals her health and ability were restored to such a degree that while under treatment she acquired a practical knowledge of vocal music of which she made suc-

cessful use. Her ability to walk without lameness is described on page 160. In 1904 the scar had been bleached and attached to bone for nine years and was probably conclusive.

TREATMENT.

The management of a case including inflamed abscesses is beset with difficulties. A knee thus affected was formerly thought to require amputation. The general rule which advises the free and early incision of all abscesses is recalled, but its authority is weakened by a mental picture of the liquefying bone which gives rise to the matter. The urgency of the symptoms may seem to call for an incision which with due preparation is considered in any event harmless, unless it meets the objection that it surrenders the protection provided by encysting membrane and gives purulent matter access to divided vessels. Much benefit can hardly be expected to follow the opening of an abscess when it is learned by experience that the date of the final closure of the sinus is not thus hastened or the course of the disease modified in any other way, effects not to be reasonably expected in view of the facts that incision has no control over the status of the bone and that the step is taken very late in the history of the abscess. A bistoury skilfully directed in an early stage might

release matter painfully imprisoned in cancellous tissue, and thus shorten the disease and conserve bone; but when pus has broken through the compact shell and lies in the cellular structures, or in the cavity of the joint, events may not be controlled by local interference of this kind. If the abscess is cold there is no painful tension; if hot, the tension of infiltrated tissues can be relieved only by multiple incision. In either case artificial closure is sought with difficulty, and when found is inferior to natural sealing, and, with the observance of all due precaution, nothing is gained by incision unless the purulent depot is scraped, and then nothing unless affected tissue of all kinds is removed and the foci extirpated, which implies in many cases excision of the joint or large portions of bone. An operation, of either minor or major surgery, does not bar the necessity of mechanical treatment, which applied to the bone early or late will ensure a recovery, with or without an operation, by the slow but sure process of natural repair. For many years the suggestion that the abscesses of joint disease might well be intelligently neglected has found frequent expression in literature. It may in due course of time receive general assent.

The appearance of an abscess is sometimes useful because it leads to cheerful acceptance on the part of the patient of the inconvenience of prolonged treatment, the necessity of which is clear only to the

physician, who needs no such reminder of the serious condition of the bone. But when an eruption occurs, indifference is apt to be replaced by undue anxiety concerning what is thought to be the most serious incident of the case, but which is really little more than a complication requiring the observance of customary sanitation. An established sinus is painless and resembles the natural openings lined with mucous membrane, and the region readily tolerates disturbance and even violence.

Significance of Abscesses.—It is difficult to explain the appearance or non-appearance of this complication except by the inconsequent statement that caries may be dry or moist. It is probable that the selection depends on the diathesis, or something liable to change in the patient's general condition, rather than on any local change brought about by treatment or otherwise. Continued suppuration has been thought to lead to visceral degeneration; but this relation has not been established, it being questionable which is the cause and which is the effect. When there is a failure of general health coincident with continued suppuration it is probable that the former is the cause of the latter.

Origin of Abscesses and Location of Sinuses.—Many attempts have been made, but without notable success, to drain the region of initial foci by working a tunnel through the neck of the femur by way of

the subcutaneous surface of the great trochanter. It is not easy to ascertain the starting-point, or route, of an abscess. Matter found in the cavity of the joint may be composed of caseous débris diluted with products of synovitis. If collections occur without communicating with the joint, the matter must have perforated the compact shell at a point beyond the attachment of the capsule. Severe pain in the early stage, unrelieved by traction and fixation and suddenly ceasing, has been thought to be caused by matter confined for a while under tension in the cancellous tissue and to presage a palpable collection of fluid. When the latter has gained headway it takes the shortest route to the surface modified by gravity and the lead of muscular and other sheaths. Thirty-five per cent. of sinuses have been observed on the anterior, twenty-seven per cent. on the outer, and twenty-five per cent. on the posterior surface of the hip and thigh, and thirteen per cent. on the inner surface of the thigh. They do not often interfere with the application of the hip splint, which makes distinct pressure only where the ischiatic and pubic bones rest on the supporting strap. The scars which follow the abscesses of hip disease may be attached to the femoral shaft, to the great trochanter, to the horizontal ramus of the pubes, to Poupart's ligament, to the sacrum, and to the crest and anterior and posterior superior spines of the ilium. They give a re-

markably dimpled or tufted appearance, especially in those who are inclined to be fat.

When exanthemata intervene in the course of purulent hip disease the affected area shares in the cutaneous disturbance, with intense redness, and a diffused swelling which gives to the sinuses the appearance of cloacæ, or caverns emitting copious thick pus. It is a common observation in cases of long-continued discharge that the patient suffers loss of appetite, lassitude, and other febrile indications when the flow ceases for a time, and that these symptoms disappear when the discharge recurs. When healing of the bone shuts off the supply of matter the part assumes a saucer-like depression, at the bottom of which a scab is followed by a scar attached to deep fasciæ or to bone. The order in which sinuses close is not necessarily that in which they open. The last to close is that leading from the point or area of bone which is the last to cicatrize.

CHAPTER VII.

DIAGNOSIS, PROGNOSIS, AND APPRECIATION OF RESULTS OF HIP DISEASE.

DIAGNOSIS.

Two diagnostic reminders, important in general practice, find expression in these words: The pain of hip disease is in the knee and the pain of spine disease is in the stomach. *Recurring Pain in the Knee*, in the absence of physical evidence of disease of this joint, should call attention to the condition of the hip. But pain, except as an alarm, is not an important indication. It belongs to the group of subjective symptoms which may be almost entirely disregarded in making a diagnosis of an affection which displays so many signals.

Inconstant Lameness.—Among the first signs is lameness, which may disappear, to return after an interval of days or weeks; it is present in the morning when the patient leaves his bed and wears off after a brief period of activity; it breaks up the natural rhythm of walking, in which equal time is given to the two feet, leaving the well foot on the ground longer than the affected one, and leading the former to give a more accentuated stroke as it hastens to re-

lieve the latter from the weight of the body. Akin to lameness is the attitude at rest, in which the patient habitually stands favoring the affected limb which assumes marked *Abduction* and slight flexion, while the weight is principally thrown on the well limb. Next to lameness in the order of obviousness is *Muscular Atrophy*, owing partly perhaps to reflex interference with nutrition and seen in a flat natis as the patient stands, and in the description of the gluteal fold, which is shorter and more shallow and depressed than that of the well side, and in the reduced circumferences of the thigh and leg.

Reflex Muscular Action.—Next in turn comes the most valuable sign of the early stage, interference with passive motion by reflex muscular action. The muscles are said to be on guard. Verneuil used the expressive term *vigilance musculaire* in a graphic description of this peculiar action or condition of the muscles which, while common to all diseased joints, is best seen in the hip, because a ball-and-socket joint depends especially on its muscular system for both motion and stability. It is a sign especially valuable when lameness is inconstant, atrophy equivocal, and the pain referred to the knee. It is also significant in convalescence. It is found earliest in rotation. Let the patient sit with the legs hanging over the edge of a table and then impart a lateral pendulum-like motion to the foot and note whether the arc

of motion is less on the suspected side; or when the patient is supine impel the limbs, one at a time, giving them a rolling motion outward and inward. On the well side the outer and inner borders of the foot will strike the table, or nearly so, while on the affected side rotation will be limited. The patient may be induced to apply a test for limited passive flexion by grasping the shin and kissing the knee. On the suspected side he may not be able to bring the knee to the mouth. These tests should be made with deliberation and gentleness, the object being to detect very slight differences in muscular action, or even to recognize reluctance of the muscles to relax in certain directions, although they may not yet by their tonic action prevent wide motion. Aside from this reflex interference with passive motion, it is informing to note the deportment of the adductors of the thigh under palpation. When passive motion is attempted they may exhibit a momentary spasm or else maintain a tonic contraction until the limb is released, when they recover relaxation; or the abdominal muscles, as well as the adductors, may show a single reflex spasm at the beginning of passive motion in any direction. These muscular indications should be sought in both limbs for the sake of comparison. To examine both sides is a rule of general application which it is never safe to neglect. A young physician, after a great variety of advice sought relief from

disability caused by what was believed to be a badly united fracture of the fibula. The supposed faulty callus was the prominent triangular subcutaneous area at the lower part of the bone. When a similar prominence was found in the other leg the imagined symptoms and the patient's apprehensions disappeared.

A Useful Diagnostic Sign has been described by Dr. Steele as a "brawny thickening about the joint in front of the capsule, or behind the trochanter." In the vicinity of inflamed bone a condensation of the soft parts may be found, not visible, but recognized by palpation or pinching, and then not clearly discerned except by comparison of the two sides. A smaller pinch of skin and underlying tissue can be made on the well than on the affected side. None of the usual diagnostic signs may be deemed conclusive by itself. They are to be considered in combination and with due regard to other conditions which produce similar phenomena. They may betray hip disease in a patient as yet free from pain and lameness.

Unmistakable Signs.—In a later stage, and when the disease is established, these minor points may be neglected because overshadowed by these three unmistakable and easily read signs: (1) constant lameness; (2) marked disparity in circumferences, due not only to disuse of one side, but also to overuse of

the other; and, (3) absence, or almost complete absence, of motion in the joint. A combination of these salient features makes a picture of hip disease which is not easily mistaken. In regard to the first and the second there is little to be said, but the absence of motion may escape detection, movements in the joint itself being so closely imitated by vicarious mobility of the lumbar vertebræ and of the other hip. The absence of motion, or the amount of motion if some be present, may be recognized by noticing the deportment of the pelvis when attempts at passive motion are made.

To Discover Lateral Motion, the patient lying conveniently on a table which is set parallel with the wall of the room, give the limb passive abduction and adduction until the iliac spinous processes are square. If passive motion thereafter disturbs the direction of the line connecting the iliac spines there is no motion in the joint. If there be some motion in abduction or adduction, there will at first be no disturbance of the iliac spines and the extent of motion will be indicated by observing the point in the arc of abduction or adduction at which the iliac spines are disturbed.

To Discover Antero-posterior Motion, raise the limb until the lumbar spinous processes rest on the table. If passive flexion or extension of the elevated limb disturbs the spinous processes there is no motion in the joint. If there be some motion there will be at

first no disturbance of the spinous processes and its extent will be indicated by observing the point in the arc of flexion or extension at which disturbance occurs.

Structural Shortening.—While apparent shortening, caused by fixation or ankylosis in a bad position, is an almost conclusive sign of hip disease, structural shortening has but little diagnostic significance. It occurs in acute epiphysitis, which is a furious idiopathic, or non-traumatic, inflammation, producing, not fixation, but the relaxation and eversion of diastasis, the preternatural longitudinal mobility of congenital dislocation, and to some extent the disability and atrophy of infantile paralysis. As traumatism is not a factor of inflammatory joint disease, it is probable that a so-called diastasis with suppuration is usually an instance of acute epiphysitis. A differential diagnosis between the results of epiphysitis, diastasis, single congenital dislocation, infantile paralysis, coxa vara, and hip disease is sometimes a matter of difficulty. As the first is a profusely purulent affection, the presence of a scar is generally a conclusive indication. As an exception, no scar was found in the patient whose shortening is seen in Figs. 108 and 109 (p. 181), but matter had found exit in great quantity by the vagina.

Congenital Dislocation of the Hip.—This is a rare and painless deformity, almost never recognized until the child begins to walk. It does not interfere with

efficient locomotion and has no reaction on health, physical endurance, or longevity. It responds indifferently to treatment of any kind. When double it produces an easily recognized "sailor" gait. When single, lameness may be largely nullified by the assumption of the equine position of the foot and the normal rhythm of locomotion.

Coxa Vara.—Many patients have probably received routine treatment for hip disease in whom reflex muscular signs were absent and whose trouble arose from coxa vara, or bending of the femur, which receives the weight of the body at a disadvantage as it falls in a direction not parallel with, but oblique to, the axis of the neck of the bone. Whatever may be the cause of this weakness of the skeleton, while it exists the relief of the affected limb from weight-bearing is desirable. If bending of the bone goes to the extreme of producing serious deformity and disability, osteotomy will be necessary and promises satisfactory results.

Synovitis after typhoid fever may simulate hip disease. A recent convalescent from typhoid presented limited motion and a distended capsule of the hip-joint. Osteitis was excluded by the history and the absence of reflex contraction and local muscular wasting. The patient was warned against undue disturbance of the joint and recovered without dislocation or any special treatment.

PROGNOSIS.

As hip disease is not in the category of affections likely to prove fatal, prognosis concerns itself almost entirely with the degree of resulting deformity and disability. At the very beginning, prognosis is largely a question of the date of the diagnosis. If this is made sufficiently early, treatment may fortunately induce resolution before the destructive process is under way. The tuberculous deposits may be absorbed or harmlessly desiccated, and the usual deformity and functional impairment may be entirely prevented. These effects seem to have followed early diagnosis and treatment in the following instance:

CASE X.—*Incipient Hip Disease.*—A girl seven years old and apparently in perfect general health had symptoms for twelve weeks which led Dr. Ross, her physician, to a diagnosis of disease of the left hip. The history included night cries following days of unusual exercise, inconstant pain in the knee, and lameness with long intervals in which the child's gait was normal. Rheumatism was excluded. The following signs were seen on October 25th, 1900: Fulness of the groin, flattening of the natis, a shallow gluteal fold, atrophy measuring one-half of an inch and one-quarter of an inch in the thigh and leg, and limi-

tation of motion by reflex muscular action when the extremes of passive motion were approached. On November 15th, 1900, an ischiatic crutch was applied for the protection of the limb, with a high sole on the well foot, and on the following day the patient was presented to the Orthopædic Section of the New York Academy of Medicine. The splint allowed the anterior part of the foot to reach the ground. The toe could have been kept clear by increasing the thickness of the high sole and lengthening the splint. This would have increased the inconvenience of the application and was unnecessary in view of the fact that pressure transmitted from the toe by way of the ankle-joint and the resistant muscles controlling the tendo Achillis was insignificant when compared with concussion passing directly through a bony column from the child's heel to the hip. Traction was postponed because it was hoped that reflex muscular action would cease when inflammation was subdued by arrest of weight-bearing. If pain had required attention, fixation would have been enforced by the addition of traction. The recumbent position would have more thoroughly protected the joint, but the steel crutch was sufficient, as it practically put the limb to bed, while the child was up and going to school. The object of treatment was to promote the resolution of subacute inflammation by relieving the limb from the duty of weight-bearing and the labor of

locomotion, with the hope that absorption or harmless incarceration would take place in a year or two years. Treatment continued for one year, and when the patient was again presented to the Section on December 20th, 1901, the only indications of previous trouble were shortening of three-eighths of an inch, and a want of symmetry not exceeding one-fourth of an inch in the circumferences of the thigh and leg. A favorable artificial environment had encouraged natural resistance to disease and extinguished the foci which otherwise would have broken into flame. When examined in September, 1904, the child was in excellent health and free from the signs and symptoms of any joint disease.

Reports of similar results following early diagnosis would be more common, if there were less reluctance to pronounce so serious a decision on an active and apparently well child. A more common history includes a record of rheumatic pain, and time passed in waiting for an outbreak of startling signs. For a long time pain was thought to be an essential feature of early hip disease. This view was held by an old-fashioned physician who said that he had pounded a patient's heel at every visit until his efforts elicited expressions of pain. It is related that, many years ago, a boy returning from a clinic explained that he had not cried so much as on previous occasions because he had given to the professors the other leg to examine.

As an early diagnosis and complete recovery are not often recorded, prognosis as a rule deals with the question of how badly the patient will be crippled.



FIG. 77.



FIG. 78.

FIGS. 77, 78.—Case XI. Third Stage, Six Months After Treatment, Age Nine Years.

In many cases treatment is begun late, and in others it falls short of full control of the disease. Histories of patients in the third stage always present interesting features.

CASE XI.—*Third Stage of Hip Disease.*—A boy six years old had suffered from disease of the right

hip for nineteen months. The primary abscess opened spontaneously in February, 1877, on the day the patient was first seen. His local symptoms were acute and his general condition was greatly depressed. Exsection had been advised. Treatment continued two years and five months. Six months after it had ceased photographs were taken, as seen in Figs. 77 and 78. Figs. 79 and 80 show the place and order of the sinuses. Locomotor ability was favored by the position of his limb, which was moderately flexed, but not adducted or abducted. His adult condition, twenty years later, is seen in Figs. 81 and 82. The outlines of his feet are shown in Fig. 83. In the absence of advice he had for twelve years operated and furnished the power for a paper-ruling machine,

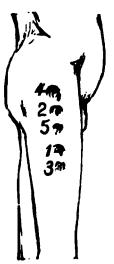


FIG. 79.

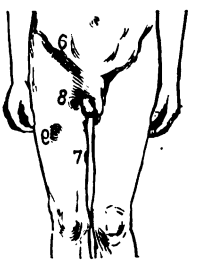


FIG. 80.

FIGS. 79, 80.—Place and Order of Sinuses in Case XI.

standing ten hours a day. He also became an expert bicyclist with a record for distance. This restless activity in work and recreation probably induced re-

current caries of the shaft with added shortening, which was largely neutralized by the equine position of the foot as seen in Figs. 81 and 82.



FIG. 81.



FIG. 82.

FIGS. 81, 82.—Case XI. Third Stage, Twenty Years After Treatment, Age Twenty-nine Years.

CASE XII.—*Third Stage of Hip Disease.*—A girl three years old had suffered from disease of the right hip for one year. Her mother, her grandmother, and

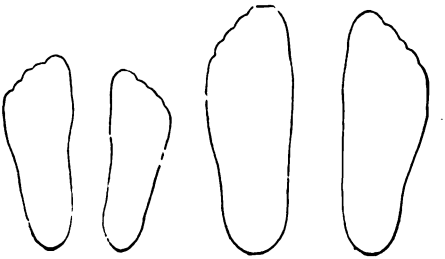


FIG. 83.—Case XI. Feet at Nine Years and Twenty-nine Years.



FIG. 84.



FIG. 85.

FIGS. 84, 85.—Case XII. Third Stage, Eight Months After Treatment, Age Five Years.

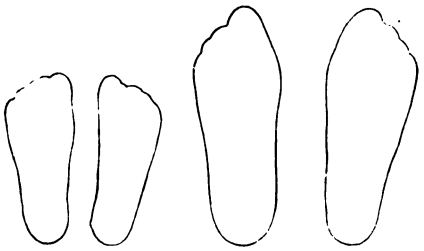


FIG. 86.—Case XII. Feet at Five Years and Twenty-five Years.



FIG. 87.



FIG. 88.

FIGS. 87, 88.—Case XIII. Third Stage, Eighteen Months After Treatment, Age Twelve Years.

several uncles and aunts had died from pulmonary tuberculosis. Treatment, begun in October, 1876,



FIG. 89.



FIG. 90.

FIGS. 89, 90.—Case XIII. Third Stage, Twenty Years After Treatment, Age Thirty-two Years.

continued two years and seven months. The result, eight months after treatment of this patient ceased, is seen in Figs. 84 and 85. Her condition was prac-

tically the same twenty years later. The place and order of the sinuses are shown in Figs. 75 and 76 (p. 135). The outlines of her feet are shown in Fig. 86.

CASE XIII.—*Third Stage of Hip Disease.*—A boy seven years old had suffered from disease of the right hip for four years. Treatment, begun in September,

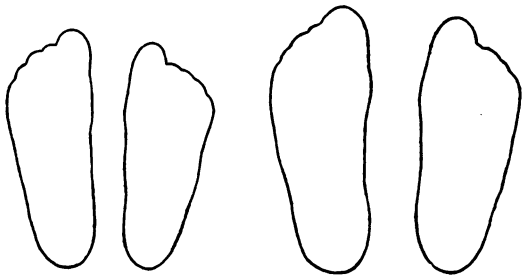


FIG. 91.—Case XIII. Feet at Twelve Years and Thirty-two Years.

1874, continued four years. His condition eighteen months after treatment ceased is seen in Figs. 87 and 88. The place and order of the sinuses are seen in Figs. 73 and 74 (p. 135) and his adult condition in Figs. 89 and 90. The outlines of his feet are shown in Fig. 91.

Functional Results After the Third Stage.—In each of these patients nothing was wanting to make a typical presentation of the severest form of hip disease. The cases are instructive because they show that fairly good results may follow treatment begun in the third stage. They are not cited to show the superiority of the instruments used. Similar results

may be obtained by the use of any apparatus, whether it is recommended by authority or devised to meet the conditions of an immediate case, provided it recognizes the necessity of fixation, protection, and convenient locomotion. Patients who are not seen until the disease is far advanced cannot be taken to represent typically the advantages of treatment. Better results are seen when timely treatment anticipates the third stage, while the best are recorded only in histories beginning with an exceptionally early diagnosis. These cases have the rather rare advantage of graphic comparison between results immediately after and many years after the cessation of treatment. They illustrate the contributions made to symmetry and ability by growth and carefully directed development. They show that excellent functional restoration may be expected in apparently hopeless cases. They confirm the opinion that confident reliance may be placed on intelligent expectation in the management of the disease and its complications. Although joint motion was practically abolished in these cases they call to mind Mr. Hilton's patient, whom he describes thus: "She is an excellent dancer, frequently dancing for a whole evening, and but few persons know, when she sits down, that the right knee-joint is bent at right angles with the thigh and body, and tucked under the chair to meet the inconvenience of her fixed hip-joint."

The patient whose abscesses were described in Case IX. (p. 136) appears as a soloist without defect in her gait, although her structural shortening measures two inches. Another patient, who formerly disturbed his neighbors by night cries, is a popular comedian, concealing his lameness, or making it a grotesque feature at will, so that friends do not know whether he is really lame or not. Such cases are sufficiently common and well known to encourage the systematic instruction of patients in the study and practice of methods of circumventing deformity in the early years of life, when habits are formed and growth is an important element in the introduction of functional ability.

MATHEMATICAL APPRECIATION OF RESULTS OF TREATMENT.

The note-book of an orthopædic clinic contains not many cases of the third stage, and fewer cases still in which early treatment has shut out all traces of disease. When comparing results in ordinary cases the degree of joint motion seems at the first view to be of the greatest importance. When the range of motion is wide the patient of course derives from it considerable benefit, especially when the arc of anteroposterior motion is wide enough to favor sitting and walking.

Amount of Motion Less Important than Position of Limb.—A slight degree of motion, however, is but little better than immobility, and as a large proportion of patients have either slight or practically no motion, it is found that the position of the limb, whether adducted, flexed, or abducted, is the point of chief interest and importance. If the joint must be almost or quite motionless the presence of moderate flexion is desirable as it favors sitting and does not seriously interfere with walking. Adduction is always deplorable because it is equivalent to apparent shortening which is often superimposed on real shortening from loss of bone and disproportionate growth. On the other hand abduction is always desirable because it is equivalent to apparent lengthening, which may compensate, in part at least, for real shortening. The idea that absence of mobility from the hip-joint precludes locomotion is not found in the mind of the physician, who recognizes the fact that vicarious motion in the other hip and in the spine offers a compensation which is attended by effective and in favorable cases almost normal locomotion.

Mensuration of Deformity.—Orthopædic practice is interesting especially because it deals with what is real and tangible. Physical demonstration is a part of daily routine. Pathological doctrines lie partly in the domain of physics and may be proved or disproved clinically, with mathematical certainty, and

therapeutic plans are worked out by the application of mechanical laws. Subjective symptoms give way to objective signs, and at the end of treatment the re-



FIG. 92.—Symmetrical Position.

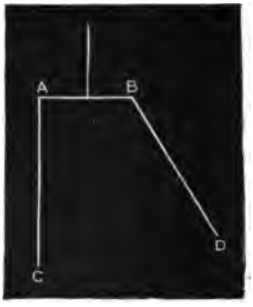


FIG. 93.—Abduction.



FIG. 94.—Apparent Lengthening.



FIG. 95.—Adduction.



FIG. 96.—Apparent Shortening.

FIGS. 92–96.—Mr. Marsh's Drawings, 1877.

sult may be expressed in fractions of an inch and degrees of a circle. In Figs. 92 to 102 the methods of observing and recording the phenomena of a case

of hip disease seem to approach the details of exact science. The well-known drawings of Mr. Marsh, which are reproduced in Figs. 92 to 96, require no explanation. The images seen in Figs. 97 and 98 are common dolls whose joints have been reconstructed in such a manner as to enable their limbs to



FIG. 97.—Flexion, 30° (1896).

be placed in positions of abduction, adduction, and flexion, the degrees of which are indicated on a graduated scale. But, on account of the rigidity of their spines, they cannot show the factitious or "apparent" deformities caused by fixation of the hip in certain positions. This is well done, however, by the pasteboard silhouettes seen in Figs. 99, 100, and 101. The facile motions of the vertebræ of these shapes

enable them to confirm the mechanics of Mr. Marsh's drawings. Their movable joints are lightly pressed shoe eyelets, two of which are posited on the background by screws at *H* in the profile and *V* in



FIG. 98.—Abduction, 27.5° (1896).

the full figure. Motion at *V* in the full figure allows the pelvis to tilt laterally, producing apparent lengthening or apparent shortening, while motion at *V*, *V* in the profile enables the pelvis to tilt antero-posteriorly for the production of lordosis. The thorax in the profile is backed with sheet brass, to allay friction between guide screws. The clip is a common

scarf retainer. The pieces before assembling are seen in Fig. 102.

To Show Production of Apparent Shortening by Adduction.—In Fig. 99, *V* in the full figure is the point of motion which answers to vertebral mobility and allows the pelvis to tilt laterally. The clip applied at *A* abolishes this motion. The limb may then be adducted, as in Fig. 100, by virtue of motion at *H*, which represents the position of the hip-joint. The clip may then be moved from *A*, where it prevents vertebral motion, to *B*, where it abolishes

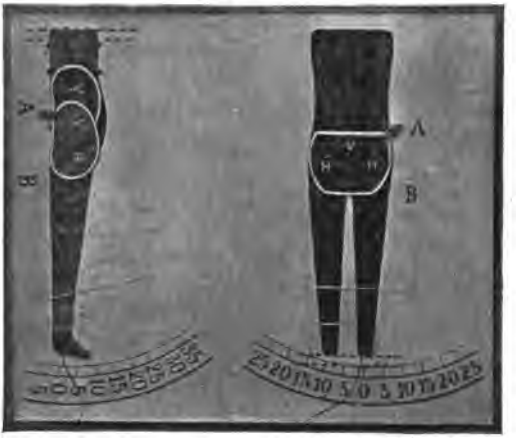


FIG. 99.—Symmetrical Positions (1896).

motion in the hip. Ankylosis in the position of adduction is thus imitated. If, now, the limb is moved into parallelism with its fellow and the axis of the trunk, as in Fig. 101, the pelvis tilts and apparent

shortening is the result. In a similar way the silhouette may be made to show how abduction produces apparent lengthening.

To Show the Production of Lordosis by Flexion.—Turning the page ninety degrees so as to show a supine profile, the letters *V* and *V* in Fig. 99 represent the points of motion which answer to vertebral mobility and allow the pelvis to tilt antero-posterior-

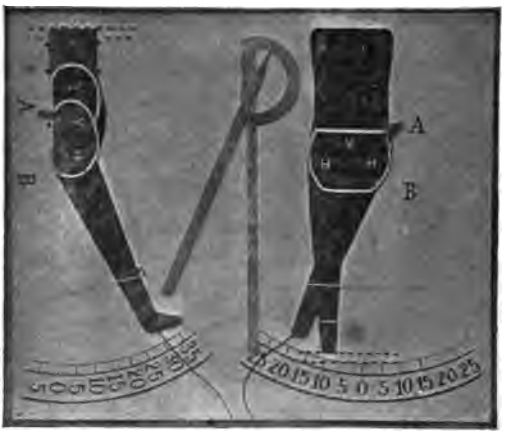


FIG. 100.—Adduction, 20°. Flexion, 30°.

ly. The clip applied at *A* abolishes this motion. The limb may then be flexed, as in Fig. 100, by virtue of motion at *H*, which represents the position of the hip-joint. The clip may then be moved from *A*, where it prevents vertebral motion, to *B*, where it abolishes motion in the hip. Ankylosis in the flexed position is thus imitated. If, now, the limb is



FIG. 101.—Apparent Shortening. Lordosis.

brought down to the table, as in Fig. 101, the pelvis tilts antero-posteriorly and lordosis is the result. It is interesting to note, by observing the relation of

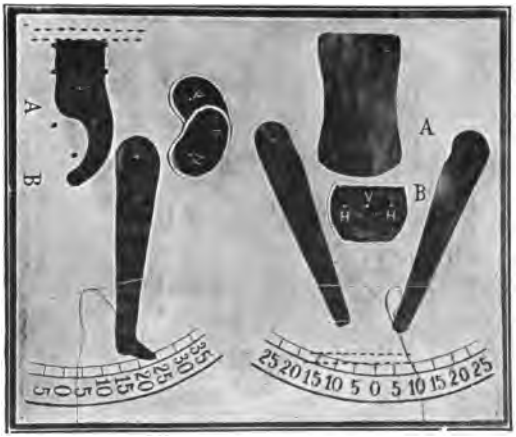


FIG. 102.—Parts of Fig. 99 Before Assembling.

the dotted lines to the figures, that height is decreased by flexion while it is decreased or increased by adduction, according as the patient stands on the affected or on the well foot.

To Measure Flexion.—While the patient lies in the supine position the limb may be raised and lowered repeatedly until a point is found at which the lumbar spinous processes press on the table. One arm of the goniometer, two forms of which are shown in Figs. 98 and 100, may then be held horizontally, while the other is made parallel with the axis of the limb. The degrees of flexion are then seen on the scale.

To Measure Adduction and Abduction.—When the point is ascertained at which the anterior superior spinous processes are at right angles with the axis of the trunk, one arm of the goniometer may be held parallel with the line of the iliac spines. For convenience, if the narrow table is against the wall of the room, the arm of the instrument may be directed point blank at the wall. It will then be parallel with the iliac spines. The other arm may then be made parallel with the limb as nearly as may be. To avoid errors which might be caused by the presence of a knock-knee or a bow-leg a line from the middle of Poupart's ligament to the middle of the heel may be called the axis of the limb. Degrees of adduction or abduction may then be read on the scale. The arc

of motion may also be conveniently noted and measured. Absolute accuracy may not be expected to follow the application of these methods, but the results will be better than those obtained by the use of the eye alone, especially after the observer has gained facility and accuracy by repeated use of the measuring instrument.

Practical Shortening in the erect position may be estimated by placing the hands on the iliac crests and observing whether one is elevated above the floor more than the other. In the supine position, especial accuracy may be sought by using a pencil, or ink, on the iliac spine, the middle of the patella, and the summit of the inner malleolus before applying a measuring tape. The relation of the great trochanter to the line connecting the iliac spine and the ischiatic tuberosity will reveal the shortening due to changes in the acetabulum and in the femoral head, and in the length and direction of the neck of the femur. In taking the position of the trochanter a comparison of the two sides is necessary to obtain a useful result.

CHAPTER VIII.

CAUSES AND PREVENTION OF THE DEFORMITY OF HIP DISEASE.

FACTITIOUS SHORTENING.

In advanced hip disease the limb is unavoidably shortened by loss of bony tissue, and to this cause may be added disproportionate development, from overuse of one limb and disuse of the other at the time of growth. But this real or structural shortening is not the chief factor of the lameness. The deformity thus produced is not strikingly obvious. A new element, however, is introduced when the limb is fixed, by either muscular contraction or ankylosis, in a position which is at variance with the ordinary symmetry of the figure. The deformity most commonly found in hip disease is a combination of flexion and adduction. But even when the limb is fixed in a flexed and adducted position, deformity is not apparent when the patient is resting; indeed, such a position is not in itself a deformity. This attitude may be taken, and is often taken, by the normal body. But when a limb thus situated, and fixed by disease, is brought into parallelism with its fellow

and the axis of the trunk, the absence of motion from the joint twists the pelvis in such a manner that factitious or apparent shortening, lateral curvature, and lordosis come into view and combine to produce the typical deformity of hip disease. This peculiar movement overshadows the effect of structural shortening and makes the hip-limp, in which one side is suddenly distorted at each step. In the characteristic lameness of hip disease, at the critical moment when the limb comes to a vertical position to receive the weight of the advancing body, the pelvis rocks forward and laterally with a rude shock. But if the limb is fixed in a good position the pelvis is level when the patient stands; and when he walks it rocks antero-posteriorly on the lumbar joints in a moderate arc with resulting easy locomotion. The bad position is assumed early in the disease, and arrest of motion or fixation in this bad position is initiated by reflex contraction and maintained through and after convalescence by fibrous ankylosis.

The Neuro-muscular Element.—Reflex contraction is an early and interesting clinical feature most thoroughly elucidated in Dr. Shaffer's valuable monograph on "The Neuro-muscular Element of Joint Disease." It did not escape the eyes of John Hunter, who referred to it when he wrote: "Stiffness of the joints depends on involuntary contraction of the muscles. I think this arises from sympathy, or a

consciousness of the parts being unable to answer to the action of the muscles, and it comes nearest to human reason of anything in the body." Dr. Davis said that the muscles were "on guard."

The Movable-immovable Joint.—A joint thus affected has a peculiar quality by virtue of which it is immovable, and at the same time movable, a condition found in some forms of paralysis in which a limb has been likened to a piece of lead pipe which firmly holds its shape and yet bends on the application of suitable force. This quality, useful in the reduction of deformity, reveals its presence in the ordinary events of practice. Recorded degrees of flexion or adduction are seen to have increased or decreased a few hours later without any obvious cause, or they are rapidly reduced by weight and pulley or hip splint, or by the use of Mr. Thomas' splint in the skilful hands of Dr. Ridlon. The limb readily changes its position in the successive stages of the disease, abduction being followed by adduction, and moderate flexion becoming extreme in the third stage. Recalling these changes in a limb stiffened by hip disease, it may be considered not far out of the way to speak of the movable-immovable joint. Fibrous ankylosis may be quite far advanced without forbidding a change for better or for worse in the position of a limb in response to moderate force applied unwittingly or by design.

Ankylosis.—When ankylosis is at length thoroughly confirmed but little may be done to loosen the cicatricial tissues and contractured ligaments. The acute stage has long ago passed in which ankylosis might have been averted or lessened by mitigating inflammation. But it would seem that in the course of treatment something might be done to bring the limb into a good position when the joint is semi-tractable, and to maintain the favorable position until it shall have become confirmed by ankylosis. The ease with which the position of the limb changes to suit the convenience and comfort of the patient encourages confidence in the method to be proposed for the reduction of the usual deformity.

Method of Averting Deformity.—Many suggestions have been made in explanation of the bad position assumed by the faulty limb. It has been thought to be due to effusion so abundant that the limb takes the position which accommodates the excess of fluid, to migration of the acetabulum and consequent change in the lodgment of the head, to spasm of the abductor muscles followed by their paralysis, giving advantage to the action of the adductors, to atrophy and attrition of the head, or to a painful spot or area on the head, which had to be revolved from the depth of the acetabulum where it would have received too much pressure from contracting muscles. In some cases and stages these conjec-

tures may answer. They take into account the condition of the joint. But the morbid anatomy of the articulation has probably, after all, very little to do directly with the position of the limb, which is more likely to be controlled by the relation which the limb bears to the rest of the body. A simple and competent explanation is found in the statement that the limb obeys an unconscious demand for a position which meets the requirements of the patient's comfort and convenience. By adduction and flexion the limb is bestowed quietly and comfortably when the patient lies down; and when he stands the foot is withheld from forcible contact with the ground. But if these comfortable and convenient conditions were to be secured in some other way, if the joint were comfortably restrained from painful movements by a splint when he lies down, and if the apparatus were to hold the limb above the risk of injury when he walks, the necessity of adduction and flexion would be absent and the limb would reach for the ground and resume its normal relation to the rest of the body. The removal of the cause would be followed by a removal of the effect.

Difficulty of Direct Mechanical Reduction.—Indirect removal of deformity in the way proposed would obviate the necessity of resorting to direct mechanical correction. It is noteworthy that an extreme deformity is more easily reducible by direct me-

chanical force than a moderate one. A metallic rod, bent as in Fig. 103, may be readily straightened somewhat by manual traction and countertraction, as in Fig. 104, and still further by the same forces me-



FIG. 103.



FIG. 104.

FIGS. 103, 104.—Straightening a Crooked Rod by the Application of Traction and Countertraction.

chanically applied, as in Fig. 105. If it is true that extreme deformity is less commonly seen than formerly, it is probably because fewer patients fail to receive traction in the third stage. It is evident, however, that the straighter the rod becomes the harder it is to make further straightening by traction. It is questionable whether traction can produce absolute straightness. It certainly cannot over-

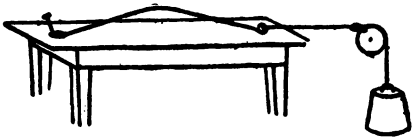


FIG. 105.—Mechanical Application of Traction and Countertraction (1895).

straighten the rod. But if traction and countertraction are replaced by the leverage of pressure and counterpressure, as in Fig. 106, the rod may be more than straightened without much trouble. Such an

application is signally useful at the knee, represented in Fig. 106, where the leverage above and below is ample. But at the hip, which is represented in Fig. 107, leverage above the joint is practically absent and direct mechanical reduction is therefore almost out of the question. Control of the position of the limb is thus seen to be beset with difficulties. Even if the

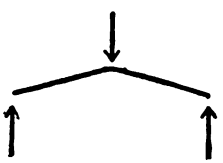


FIG. 106.—Rod Representing Knee Joint Easily Straightened.

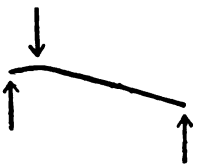


FIG. 107.—Rod Representing Hip Joint Straightened with Difficulty.

FIGS. 106, 107.—Straightening by the Application of Pressure and Counterpressure.

deformity were reduced mechanically, or corrected by osteotomy, it is probable that the demands of comfort and convenience, when the patient returned from recumbency to the use of his feet, would incline him unconsciously to seek comfort and convenience by reinstating adduction and flexion. The effect would again follow the cause.

The Effect of a Return to Normal Rhythm.—The patient unconsciously assumes deformity in order to avoid contact with the ground, which he touches with the affected foot for a moment, withdrawing it promptly as if to move it out of the way of the well

limb, which hastens to do the work of progression. The two feet share equally in the mischief. The affected one is in a hurry to leave the ground, and the well one is in undue haste to strike the ground. If a patient walking in this pernicious way is equipped with something that holds him above the reach of pain and allows equal use of both sides, he may also unconsciously moderate the haste of the well foot and allow the foot of the affected side to seek the ground promptly and do its share of the work. From the beginning of his trouble the patient has favored the faulty limb and thus gained the habit of spoiling the natural rhythm of walking, in which the feet mark equal time. He limps in order to make the well foot remain on the ground longer than the other one. If an applied apparatus makes this unnecessary, the feet will be free to move in equal time and the limb to resume a normal position.

The argument for this method of reducing the deformity of hip disease may be concisely stated in these words. The patient unconsciously assumes a bad position in order to secure fixation and to escape painful contact with the ground. At the same time the well limb usurps more than its share of work and thus introduces false rhythm in the act of walking. If a splint secures fixation and protection the bad position becomes unnecessary, and if the patient voluntarily substitutes normal for abnormal rhythm

the affected limb seeks the ground to do its share of work and the bad position is reduced.

The suggestion of this mode of removing deformity had its origin in the observation that certain patients recovered in good form, who for some reason or other had tried to suppress or conceal lameness while wearing a splint. They seemed to have discovered for themselves that the way to avoid the appearance of lameness was to make the two sides of the body move alike. A pretty girl, naturally vain, strove constantly to appear well and wore the splint with but little defect in her gait. She recovered with no adduction and only ten degrees of flexion, although the shortening from loss of bone measured two inches. The following is another instance:

CASE XIV.—*Unconscious Correction of the Deformity of Hip Disease.*—A girl, five years old, when first seen in May, 1880, had suffered from disease of the left hip for eighteen months. A weight and pulley and a diet consisting of small portions of mutton broth were replaced by a splint and by a liberal menu. Through-and-through drainage had been established and exsection had been advised. In due time locomotion was resumed and scars took the place of sinuses from which pieces of bone had been expelled. She was the only daughter and constant companion of a careful mother. The fact of disability was not referred to in conversation and its appearance was

excluded so far as possible. The child made good use of the affected limb, protected by the splint, and walked without a very noticeable defect in her gait. Health and strength were entirely restored and recovery was marked by two inches of bony shortening, only three degrees of adduction and practically no flexion, lameness being evident only when she was in haste or moved carelessly. The good position of the limb and her general health were maintained until her fatal illness, which is recorded in Case XIX. (pp. 215, 216).

On the other hand, a boy five years old, whose mother was employed away from home all day, shared the sports of three healthy brothers and recovered under the same treatment and from a milder form of the disease with twenty degrees of adduction and fifty degrees of flexion, a result which was later made the subject of successful osteotomy. The abscess in this case is described on page 132.

Another child, in a large family, where circumstances precluded ordinary parental care, recovered without an abscess and with forty degrees of adduction. Her deformity was completely and easily reduced in a hospital ward by recumbency and a weight and pulley, but it promptly returned when the child went home and resumed the hip splint with which, disregarding advice and instruction, she maintained an asymmetrical gait.

It has not been found easy to reform the pernicious gait acquired by a lame child. The bad habit begins early in the disease. It is the first sign of trouble. Groups of muscles fall at once into disuse, and other groups are unduly developed. In this state of affairs the readjustments of muscular activity and development called for by a return to normal rhythm, are not made without some trouble. Such an undertaking will meet with especial difficulty in the case of an adult. In the tractable years of early life, however, when the muscles and joints are increasing in size with the growth of the whole body, and when new methods of walking or marching are welcomed as diversions, such changes are more readily made and should not be left to chance, but intelligently directed so that they may assist and not impede successful locomotion in adult life. What is more abhorrent than the thought that the daily wonder of juvenile growth is adding to the misfortune and helplessness of the crippled condition?

STRUCTURAL SHORTENING.

Real shortening is simple in its causes when compared with the shortening produced by fixation in a bad position. It follows acute epiphysitis of the hip with the result seen in Figs. 108 and 109. It is seen in single congenital dislocation of the hip. In-

stances are often found after infantile paralysis from disuse of one side and overuse of the other, and it is seen more rarely in those cases of unilateral atrophy or congenital asymmetry which are marked enough



FIG. 108.



FIG. 109.

FIGS. 108, 109.—Shortening Five Years After Acute Epiphysitis of Left Hip. Girl nine years old. Spinal curve reduced by factitious lengthening (1877).

to cause disproportion in the length of the lower limbs. Fracture of the femur of the longer limb and union with shortening has been proposed, but not often practised, as a method of obviating the effect of structural shortening.

Local Hyperæmia and Anæmia. —Interesting suggestions are derived from an observation, reported by M. Broca, of the effect of local hyperæmia on the rate of growth. In a case of aneursymal varix following wounding of the crural artery and vein in a child it was found, fourteen years later, that limping, which had been supposed to be due to weakness of the limb, was the result of lengthening of more than an inch. The foot also was lengthened. Such cases are said to be attended by preternatural growth of hair on the limb. Hyperæmia, induced by constriction applied to check the venous flow, is easily practised and has produced good results in the cases of joint disease reported by Dr. Freiberg. This, combined with anæmia, induced by rolled or laced bandages applied to the longer limb, might be expected to promote symmetry in cases of structural shortening. At the same time the labor of walking might be redistributed by an ischiatic crutch and a high sole in order to retard the growth of the longer and hasten that of the shorter limb. It is stated by Helferich that physiological as well as pathological growth may be increased by hyperæmia, and that a young growing bone may, under this influence, become thicker and longer. Reinforced by the activity which possesses the development of tissue at the time of growth, such methods give room for a reasonable expectation of success.

To Circumvent Actual Shortening.—The first practical resort is usually to a high-soled shoe for the short limb and the removal of part of the sole from the shoe of the long limb. In suitable cases the well-known *Extension Shoe* is useful. A durable form of this shoe, weighing two pounds and four ounces, is seen in Fig. 110. In many cases if the shortening is not extreme the desired effect may be found, and with less obvious deformity and inconvenience, by discarding the high sole altogether, withholding the heel from the ground and walking tiptoe on the affected side, as is done by the patient seen in Figs. 81 and 82 (p. 154).



FIG. 110.—Extension Shoe of Wood and Steel. Length of limb varied by adjustment of straps and buckles (1896).

The *Equine Position of the Foot* is enforced in an extension shoe. It is cheerfully adopted without a murmur of discontent by those who wear fashionable high heels, by which the stature is increased without

a total loss of grace. The foot takes this position in the *pirouette* of the ballet, and in statuary which expresses the lightness and activity of the human figure. As the toe alone touches the ground when a hip splint is worn, patients easily continue in the habit of walking in this way when they are advised to do so and to avoid a high sole; and when recovery follows a very prolonged period of treatment, a structurally shortened tendo Achillis decidedly favors an equine position of the foot. Since standing on tiptoe increases the stature, it is certainly reasonable to lengthen a limb which is unfortunately short by standing on the toe of that foot. This will facilitate efforts to practise and acquire a symmetrical or normally rhythmical gait.

LIMPING, OR LAMENESS.

It is well to bear in mind that the lameness which attends a short limb depends not so much on visible want of symmetry in the lower extremities as on a faulty carriage of the body. If the two sides of the body in general move alike, or symmetrically, the details of measurement are unimportant. Lameness in general may be defined as asymmetrical locomotion. It is said that horse dealers will on occasion conceal the defect in an animal lame in the left forefoot, for instance, by a cruel device which makes the

horse lame in the right foot also. A wedge is placed between the shoe and the well hoof, causing trouble on that side which duplicates the disability and hides lameness by balancing defective action. Infantile paralysis often vitiates the gait by introducing tardy action on one side, which may be duplicated by an effort on the part of the patient to make the well side imitate the affected one. Lameness then gives way to the rolling gait of a jolly tar ashore. A well person can walk lame at will by giving more time to one foot than to the other, a matter of easy demonstration if the experimenter will walk across the room, taking pains to let one foot linger on the floor at each step, marking time as follows: 1..2.....1..2.....1..2. Conversely, one who is lame may lessen the appearance of being so by observing the natural 1..2..1..2..1..2..1..2 rhythm of locomotion which is more effective in banishing a limp than the equine foot or extension shoe.

The Rhythm of Human Locomotion has perhaps not received the attention to which it is entitled. When normal it is absolutely simple in comparison with the varieties seen in quadrupedal action. The time is of course equally divided between the two feet. When rhythm is abnormal, the giving of more time to one foot than to the other introduces lameness. True time may be expressed as follows:

1..2..1..2..1..2..1..2..1..2..1..2..1..2,

and false time thus:

1..2.....1..2.....1..2.....1..2.....1..2.....1..2.

In a child who shows a limp, and no other sign, it is not easy to say off-hand which is the affected limb. Attention will show that the sound limb strikes a quicker blow than the other, and remains longer on the ground.

Symmetrical Walking.—Aside from the proposed method of correcting adduction and flexion in patients who are under treatment, it remains that the habit of symmetrical walking by those who are lame from hip disease, or from any other cause, is practicable and desirable. A good degree of excellence in walking is attainable by those who are badly disabled. Instances of this have already been cited, and similar cases have doubtless been observed by others. That they are not more common is probably because sufficient attention has not been given to this subject in practice. More time accorded to the prevention of lameness by simple and commonplace methods would relieve many cripples of a large part of their misfortune. It is difficult to set limits in suitable cases to the success of efforts of this kind in the formative stages of childhood and adolescence. The development of the necessary muscular fibres by daily systematic use and the natural growth of the affected and related parts combine to bring about a result which cannot well fail to be permanent. In

a child thus brought up all the muscles and joints and co-ordinate acts of the body will conform as growth progresses with increasing facility and accuracy with the demands of improved locomotion.

The Acquirement of Correct Rhythm.—Some children will fall into the new order of such a curriculum with readiness and pleasure, while others are likely to be wilful and impatient of additional restraints and regulations. One or two efforts to walk in good time, or an occasional exercise, will be without effect. Instruction should include the repetition of a systematic drill, a procedure orthopædic in view of the etymology of the word, an educational process like the training of a military recruit. From force of habit the learner should mark correct rhythm in walking, as a soldier carries out the manual of arms under fire, as a matter of habit or second nature. Time should be counted in the promenade, as in a music lesson, line upon line and precept upon precept. In these efforts to induce correct action attention should be paid to both of the feet, the affected one being taught to remain longer on the ground and the well one not to strike the ground too soon. Dancing exercises will not be out of place. Personal vanity may be stimulated, and an ambition to appear well. A wall mirror will help an observant child to improve his gait. An impressive deportment should especially be encouraged in those who

are disabled. If naturally healthy children are benefited by military drill and instruction in dancing, it is still more important that the afflicted should have these educational advantages. Treatment carried out in this way may involve trouble, and the time of skilled and patient attendants will demand outlay. When convenient, instruction might be given and exercises might be repeated in classes, with music and competitive drills by mimic military companies. The probable result would be seen in adults with but moderate lameness in place of numbers whose obvious defects entail a lasting disability.

CHAPTER IX.

POTT'S DISEASE OF THE SPINE.

THE presence of tuberculosis is discovered with more difficulty in the spinal column than in any other part of the skeleton. The bodies of the vertebræ lie behind barriers of bone, muscle, and viscera, as far removed from the surface as possible. For this reason the discovery of disease here comes as an unpleasant surprise. Disintegration will have made great progress before the contour of the back shows even so slight a break as that seen in Fig. 111, which indicates the loss of considerable substance from one or two of the vertebræ. This angular projection is the first objective warning of Pott's disease, although earlier and doubtful signs are a lateral deviation and a timid or repressed gait.

When the articulation of a long bone is diseased the effect of deranged motion is projected to a distance, reaching the circumference of a circle of which the long bone is the radius; but when a short and irregular bone is affected, the radius of disturbance is decidedly circumscribed. Lameness invites attention to disease in the lower extremities long before loss of bony tissue produces real shortening

and deformity. But when the spine is diseased locomotion is but little affected and limitation of motion is not readily perceived. The result is that diagnosis is usually necessarily postponed until excavation of the vertebral bodies and loss of large portions of bone produce a positive and unmistakable deformity.



FIG. 111.—Normal Curve Broken by Caries at the Eleventh Dorsal. Boy four years old. Duration of disease four months. (Bellevue Hospital, 1877.)

It is disconcerting to reflect that this malign process may be undermining the bones of the spine, the foundation of the edifice, so to speak, for so long a time undetected even under careful observation and acute suspicion. If such foci of disease are resolvable, when favorably situated in those parts of the skeleton which are exempt from weight-bearing, then arrest of this function of the spine should without

delay follow even slight suspicion of trouble. Ready acceptance may well be given to published reports of instances of early and tentative treatment followed by retention of normal shape and ability. In youth, when the resistive and reparative powers share in the vigor which the whole body exhibits in its rapid growth and development, it is desirable to encourage the tissues to wall off such an infection, and reasonable to expect good results from timely treatment.

Pott's Disease in the Aged.—Although pre-eminently a disease of childhood, it may not be forgotten that Pott's disease occurs at all ages, and is not easily detected in the later years of life, when its presence may be obscured by spinal stiffness and deformity so commonly observed as the results of rheumatoid and other affections which visit the vertebral column in old age. The gait and deportment of the patient, so important in the early diagnosis of this disease in children, may be overlooked when the patient is in advanced life, but none of the other usual signs and symptoms may be safely neglected.

DIAGNOSIS.

Pain in the stomach is the most important symptom. Two lines which should find a place in the *vade mecum* are: The pain of spine disease is in the stomach and the pain of hip disease is in the knee. A pre-

scription for recurring colic should be preceded, or presently followed, by a careful inquisition concerning the health of the vertebral column. Inspection may reveal a projection in the median line, which may be located by counting from the seventh cervical vertebra, or from the fifth lumbar, which lies between the posterior superior spinous processes of the ilia, or one enumeration may be verified by the other. Dr. Whitman states that the fourth lumbar vertebra, on a line with the highest point of the crest of the ilium, is the most constant landmark from which to count, the umbilicus being near the same plane. The rounded back of rickets, or that of spastic contraction, should not be mistaken. In the lower dorsal region, from the sixth to the ninth vertebra, it is also well to avoid a peculiar source of error. Here the spinous processes incline downward, overlapping like the tiles on a roof; and when a thin patient bends forward they approach the horizontal and make a projection leading to unnecessary apprehension, which may be avoided by noticing whether the projection is angular or not. Lower down the summits of the spinous processes in a thin person may be occupied by distinct calluses, caused by the pressure of the clothing; but these move with the skin.

The expression **Angular Curvature** has been criticised on the ground that an angle and a curve are essentially different. In practice, however, the term

is convenient, the normal long curve being broken into two short curves, meeting end to end in an angle. This point may not project far, but if it marks the union of two curves, in even a slight degree, as in Fig. 111, it means that destruction of bone has occurred. An angular curvature is usually an absolute demonstration of the presence of Pott's disease.



FIG. 112.—Equilibrium Restored by Lordosis. Age seven years. Ninth dorsal. Duration two years. (H. Gibney, 1900.)

Equilibrium Preserved by Lordosis.—When a considerable angle is present lordosis promptly restores equilibrium. In Dr. Homer Gibney's patient (Fig. 112), the deformity throws the upper part of the body forward, compromising equilibrium, which is safeguarded by a compensating curve below. The same is seen at *A* and *B* in Fig. 113. Lordosis, scoliosis, and kyphosis denote the three directions of spinal curvature. Lordosis is transient. Except in opisthotonos it does not have the rigidity common to the other forms of deviation, and it disappears with recumbency. It is an adventitious or incidental curve, seen in double congenital disloca-

tion of the hip, and also when a weight is carried in front, as in gestation. It accompanies the flexion of hip disease, or that produced by a shortened psoas

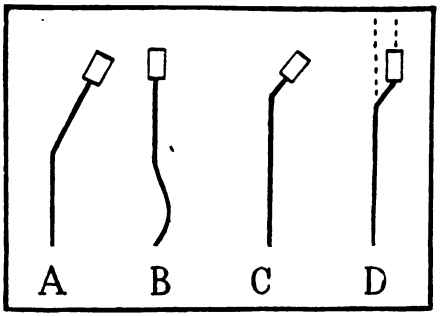


FIG. 113.—Equilibrium Restored by Lordosis and Horizontal Vision by Extension of the Head (1901).

muscle in Pott's disease. It is seen in the saddle-back of pseudo-hypertrophic muscular paralysis. Enforced lordosis at the lower part of the spine would probably counteract the effects of puerperal dislocation of the pelvic bones, as was pointed out by Dr. Goldthwait at a recent session of the American Orthopædic Association.

Diagnosis in the Cervical Region.—It is often difficult to distinguish between caries in the middle and upper cervical region and rheumatic stiffness of the posterior muscles of the neck. Disturbance of the head is very positively resented in both affections, and even when the wry-neck is the result of caries an angle is not easily perceived, the cervical proc-

esses being small, separated by narrow intervals and hidden by the muscular masses of the superior fibres of the trapezius. In some cases a point may be gained by looking for displacement forward of the axis of the head, which is produced by the action shown at *C* and *D* in Fig. 113. At *C* the head is inclined forward by kyphosis in the cervical region,



FIG. 114.



FIG. 115.

FIGS. 114, 115.—Cervical Disease. Forward displacement of axis of head. Age fifty years. Duration five years. Horizontal vision restored by extension of head. (New York Hospital.)

when the necessity of maintaining horizontal vision induces extension of the head and produces what may be called lordosis above the seat of disease. The result is a forward displacement of the axis of

the head, seen at *D*, and also seen in Figs. 114 and 115. This patient, fifty years of age, presented the widening and prominence of the upper and back part of the neck, which is admirably shown by a cut in Dr. Young's treatise. She had been entirely disabled for many months, in which her head had been flexed and tilted to the left. Relief had been sought by manual support of the head and by the careful arrangement of many pillows at night. The lower part of the spine and all of the other joints were normally flexible. When observed in 1901, and again in 1904, painless crepitus was produced at will by rotation to the right with the head flexed and supported by the left hand. It was always the same, being composed of three or four closely connected sounds. Occurring sometimes unexpectedly it was alarming in its distinctness. It was thought to be analogous to the crepitus not uncommon after disease in other joints, and could hardly have occurred after Pott's disease except in the cervical region, where the vertebræ have considerable mobility.

To make a diagnosis before the appearance of deformity, several things may be borne in mind. The child avoids stamping with his heels and puts more weight on his toes than is customary; or he walks as one stepping on a surface liable to break; or the line made by his head as he moves across the room is straight and not the undulating line traced by the

rise and fall of the figure in the buoyant gait which belongs to childhood. The deportment is then to be considered. He will play quietly by himself; or, easily tired, lean across his mother's lap; or, if the disease is at a high level he may support his head manually when sitting and even when walking. His forehead may rest on the edge of a chair, his hands being busy with toys on the floor. He is disturbed by the jar of a carriage or street car. The progress of a rough game may be interrupted by a seizure of gastralgia, laughter ending in tears. A common sign is a frequent or habitual grunt with expiration. By following these lines of observation a positive diagnosis may happily be made before the unmistakable angle appears. In diagnosis but little attention may be paid to the general condition. Many cases are encountered in which the health is good in every stage, as shown by normal appetite, good digestion, and wholesome facial expression and color. While these signs of general well-being are persistent the insidious foe may be in quiet pursuit.

Unexpected Clinical Features.—In two points thus far the unexpected has claimed attention. The pain is in the stomach and not in the back, and the health seldom shows a reaction. Another surprising clinical feature is seen in the fact that, although the back is virtually broken in Pott's disease, the local disability which usually attends fractures is very rarely ob-

served. So true is this that in the presence of spinal pain and disability the prompt conclusion is that the affection is not Pott's disease. When these alarming symptoms, pain and disability, are combined with a frank onset, it is necessary to consider the possibility of cancerous disease involving the vertebræ.

CASE XV.—*Malignant Disease of Vertebræ.*—In 1884 a boy, four years and eight months old, had been noticed walking and stooping carefully and stiffly. The contour of the spine was nearly or quite normal. Pott's disease was recorded by independent observers and preparations were made for mechanical support. Six days after the first examination paraplegia occurred, and two days later a catheter was required, withdrawing pus and blood with the urine. The bowels were regular and pain in the back was urgent. The abdomen was tympanitic. There was no œdema of the limbs. The temperature was 101° F. Occasional slight convulsions were noted. Ten days later death occurred after partial disappearance of the paraplegia. The autopsy revealed no caries, but many tumors were found attached to the dorsal vertebræ and the ribs. The largest was about two and a half inches in diameter. The neoplasm had entered the vertebral foramina.

CASE XVI.—*Malignant Disease of Vertebræ.*—In 1885 a man, thirty-five years of age, had suffered

much for several months with pain in the thighs from supposed renal calculus. There was great loss of flesh. Painful disability was so extreme that he could with difficulty lie down or rise from a couch. The spinal curves being normal, Pott's disease was excluded, a former diagnosis being reversed. When an autopsy was made five months later, malignant growths were found in the lungs and on the diaphragm and vertebral column.

CASE XVII.—*Malignant Disease of Vertebræ.*— In 1890 a brace was applied to the spine of a man who was paraplegic from supposed Pott's disease, following a strain when helping to lift a piano. The eighth dorsal vertebra showed a slight angular prominence. After ten weeks, in which the history included fæcal and urinary incontinence, an exploratory opening made in the vertebral canal, with the hope of relieving the paraplegia, exposed an unsuspected sarcoma. The patient lived a few days, and inspection was not carried further. The chief points of differential diagnosis, as formulated by Dr. Myers, are: Deformity present in Pott's disease and absent in malignant disease; and local pain and disability, absent in Pott's and present in malignant disease.

Deplorable Effects in the Dorsal Region.—The joints of the spine are, from their position near the centre of gravity and motion, peculiarly exposed to mechanical disturbance. In this respect their environ-

ment is the counterpart of that of the hip-joint, which was so forcibly described by Mr. Charles Bell (see pp. 98, 101). For this reason among others caries of the vertebræ is a most serious affection. Very much, however, depends on the region involved. In the dorsal region, excepting malignant trouble, it is probably the most serious affection that may visit the growing skeleton. Here the disease is likely, if neglected, to extend for a considerable distance along the spine, with liquefaction of large portions of bone and a portentous kyphosis, because here the column is at its greatest mechanical disadvantage. The effect of a transverse strain diminishes as the ends of a column are approached. In the dorsal and lumbar regions rotation adds to mobility when the spine bends laterally, and in the former the movements of respiration subject the diseased bones to habitual traumatism. In the cervical region the vertebræ have less weight to carry. In the lumbar region the vertebral bodies by reason of their size exhibit a firm relation of mutual support. This natural support is so strong and the effect of a lever so near the end of a column is so weak that mechanical support given to the lumbar spine is not practically a useful application. For these reasons tuberculosis of the vertebræ and its effects are less to be dreaded in the upper and lower regions than in the dorsal region of the spine, where the intractableness of the affection

and its serious results are but too well known. Here the demand for painstaking and urgent treatment is imperative.

TREATMENT.

Whatever the difficulties, authorities unite in the opinion that *nil desperandum* should be the rule when treating Pott's disease. The tuberculous process in this as in other parts of the skeleton may not be cut short by operative, or any form of positive, procedure. The cessation of this form of morbid activity may, however, be confidently predicted, and a suitable mechanical environment, reinforced by the vitality of adolescence, may be relied on to hasten the advent of the natural process of repair. The undermined vertebræ may be placed in their best expectant attitude by restraining the facile movements of the column, by taking from it the burden of impending weight, and by averting the jar which it feels at every step in walking and running.

Recumbency.—In the treatment of hip disease, while the patient is up, the limb is put to bed, so to speak, by ischiatic support, an effective method not applicable here. The recumbent position may therefore be prescribed and continued so long as it is practicable with due regard to the patient's age and general welfare. It is clear that in this position the

spine is free from weight-bearing and concussion and, to a limited extent, from motion. Recumbency in a young patient may be enforced by the use of Dr. Bradford's admirable portable frame, made from steel tubing, and arched by Dr. Whitman at the level of the disease to oppose deformity. On this the child enjoys freedom from disturbance which might excite the morbid process or delay its resolution. The environment thus secured is eminently hospitable to the approach of repair and recovery. The width of the frame is from six to nine inches, the width of the body, not of the shoulders. The undershirt is cut up the back and buttoned only behind the neck, the rest of the clothes, or blankets, going around the frame. The patients wheel themselves on suitable wagons in the house and are carried into the open air, perfectly happy and contented for a year or more. Dr. Napier, describing the arrangement, writes that in this way he treats children up to nine or ten years of age, and adds that he thinks no other method its equal.

Mechanical Support.—But when the patient gains in weight and size, and the demands of education in various ways become imperative, it will be desirable to resort to some method not incompatible with walking. It is evidently not an easy undertaking to arrest motion in the many-jointed spine. In white swelling of the knee a simple retaining brace fixes

the joint with a leverage which is wanting in a similar application made to the spine. In the hip fixation is successfully and with advantage developed by traction, and this may be applied to the uppermost region of the spine when the patient is recumbent. But in the erect position traction is not conspicuously successful as a fixative. Suspension of the head by the jury mast, applied to avert impending weight and straighten the column, is attended by an uncertain degree of fixation, theoretical rather than practical, and not to be compared with the comfortable fixation which is developed by traction of the leg. It may therefore be inferred that fixation of the erect spine is to be sought only by applying a retentive lever designed for making pressure at the level of the projection and counterpressure above and below. An obvious effect of this application is a redistribution of intervertebral pressure. As the column inclines forward, making a salient posterior angle, there is a critical increase of pressure from impending weight on the anterior rim of the affected vertebra. A brace at once takes off some of this traumatism and puts it on the posterior and sound part of the bone. It is a faint imitation of the admirable mechanics of the hip splint which transfers weight from the affected to the sound limb. Injurious pressure is thus mitigated and a barrier is thrown up at the same time against increasing deformity.

If such an apparatus, efficient in theory, proves not to be mechanically perfect in practice, it will still be found to be useful. The presence of a succession of jointed short bones instead of a single long bone above and below the diseased point introduces an element of inefficiency in the action of this otherwise admirable apparatus. The force applied to oppose deformity is unfortunately largely absorbed in bending backward sound portions of the column above and below the point of disease. And yet a useful degree of fixation may be made, enough to check gastralgia, to promote comfortable activity on the part of the patient, and to secure a diminution of ultimate deformity. It is important and interesting to observe that in this way an incidental improvement is secured in the patient's figure. As the spine yields to pressure, lordosis is formed above and below the projection, and the trunk acquires a general straightening and a fulness of the chest, which modify the typical deformity produced by this affection.

Incidental Improvement of the Figure.—Long-continued wearing of such a brace, even after consolidation is assured, changes the figure by lessening the roundness which is usually seen behind the shoulders and by giving prominence to the chest, which is a decided improvement. The torso of a young patient may be seen to double its size with the child's growth. The adolescent years in such a case may

therefore well be occupied by mechanical support of a positively antero-posterior kind, which will give ever increasing benefit from its coincidence with the period of growth and development. Indeed, if effective, the brace will be so comfortable and helpful that the patient will prefer to continue its use long after removal has been prescribed. It is only in the dorsal region that the brace can thus exert an influence on the figure. In other regions treatment may be discontinued when consolidation is completed.

Natural Reaction and Consolidation.—It is not to be hoped that mechanical treatment will at once induce consolidation. This will wait for the appearance in due time of natural reaction, but it is not difficult to believe that nature will more promptly intervene when distress and weakness and apprehension are replaced by a feeling of strength, which finds expression in the face and attitude. If it were only possible successfully to apply positive means for the arrest of the tuberculous process, the damaged vertebræ might be treated at once as if they had sustained a simple fracture. Instant provision should then be made for consolidation or union. Coaptation of the fragments and their retention in position should then be sought just as they are after a fracture of any part of the skeleton. If tuberculous action were really absent it might be well even

to adopt the periodically rejuvenated proposition to break the angle and straighten the spine. Otherwise such a ruinous procedure as **Forcible Correction** should not be added to the burden of traumatism which the tuberculous spine carries as the centre of motion for the whole body.

Details of Mechanical Support.—The steel brace has a feature which is invisible, and yet of the greatest importance in the tractable quality of the metal used. On this depend the efficiency of the application and the comfort of the patient. To secure these ends in full measure requires the most studious attention. The form of the brace before its application will be determined in a general way by the shape of the patient's back, and yet almost at once the latter will be changed for the better by contact with the brace and in turn an improvement in the shape of the brace will be seen to be desirable almost immediately. Thus the patient's figure and the brace will alternately take on progressive changes by a series of slight but imperative modifications of the apparatus which require the frequent exercise of skill and ingenuity. The growth of the child will call for some of these changes; possible diminution of the angle will determine others. Considerations of comfort will lead to more or less radical alterations in the apparatus. These changes may be sought by bending or straightening the frame of the brace, by substitut-

ing stronger parts for those that have come to be too weak, and by shifting the position, direction, and tension of buckles and straps. Too much attention cannot be given to the ever-recurring problems which such a case presents.

Rule for Regulating Pressure.—A spinal column yielding under the weight of the head and upper part of the body resembles an edifice requiring temporary support while necessary repairs are being made. But the spine can be supported only by pressure made on the sensitive and easily wounded skin, which interposes an imperative and serious limit to what can be done in this direction. A brace is indeed an outside skeleton like those of the crustaceans referred to on page 54. A practical rule therefore formulates itself as follows: The apparatus may be considered as having reached the highest point of efficiency when it makes the greatest pressure on the projection compatible with the integrity of the skin. By assiduous care and attention this seemingly harsh rule may be strictly observed without compromising in any degree the comfort and convenience of the patient. If, contrary to common prudence, the brace is fastened in place at once as tightly as it can be borne, the skin will immediately react with pain and ulceration. But if the pressure is lightly applied at first, and gradually and carefully increased from time to time, it will be found as the

weeks and months pass that the skin will have become hardened without losing its integrity or causing discomfort, and its condition will indicate whether or not the patient is receiving the full benefit of mechanical treatment. It has been proposed to avoid the vulnerable skin and support the decadent vertebræ by wiring their processes together. The suggestion was ingenious, but its cleverness did not save it from failure through structural weakness of the young and recently ossified processes. If, through negligence, abrasion and ulceration occur, the urgency of the application should be relaxed, to be resumed later with more watchfulness and care. An affection so insidious in its action and so likely to be followed by disastrous consequences demands the most efficient, albeit difficult, treatment.

The Plaster-of-Paris Jacket.—It may be questioned whether a process so laborious and involving so many nice details is practicable, whether so much time can rightfully be given to these cases, so numerous in an orthopædic clinic. The serious and disabling effects of the disease, however, cannot but urgently call for liberal expenditure of effort, which should be the more insistent because at the age of these patients every slight betterment represents a more conspicuous gain extending into adult life. Other methods of treatment, including forced extension in the prone position and plastic dressings, may

not be strictly governed by the rule proposed for the regulation of pressure. Such methods, however, are highly commendable. They call into play a diffused pressure, not very liable to wound the skin, but not readily adjustable in degree and direction. The introduction of the plaster-of-Paris jacket especially has conferred benefit on vast numbers of sufferers who would otherwise have been denied mechanical relief. In Pott's disease, as in all orthopædic practice, there can be no hard-and-fast rules as to the design or material used in the apparatus. No method has proved to be better than all others on every occasion. Questions of detail are to be met and answered as they present themselves, and no case will release the physician from the necessity of studious and persistent readiness to meet the mechanical emergencies as they arise. In the upper regions of the spine, for instance, the head may be supported by a stock-like collar, or a jury mast with flexible rests for the chin and occiput, or a less conspicuous unyielding support for the forehead or chin, or both. The latter may rise from a brace provided with well-padded curved pieces surmounting the shoulders. In any of these ways the weight may be partly removed from the spine to the shoulders, or hips, or transferred to the posterior section of the column, with comfort and advantage.

RESULTS AND COMPLICATIONS.

Among the results of Pott's disease is **Reduction of Stature.** Valuable tables, showing the rate of growth in spondylitics, have been prepared by Dr. H. L. Taylor, revealing the important facts that the rate of growth is higher for patients who are under strict mechanical treatment and efficient manipulation, and that a low rate calls for further support, or resumption of support, if it has been discontinued. Reduced height is caused chiefly by the shortening of the spinal column. It is supposed, but not yet demonstrated, that an important cause is retarded general growth from malnutrition accompanying the disease. The disproportion in the lengths of the trunk and the limbs is especially seen in patients who would have been tall men and women if the spine had not been shortened by disease. In the act of sitting the head and shoulders of such a patient descend until they are considerably below the common level, as seen in Fig. 116. This has led to the suggestion that prosthetic apparatus might be applied to lessen this appearance. In Fig. 117 such an apparatus is represented as supporting the trunk with the head and shoulders near the normal level. Worn under the clothes, it should collapse when the wearer rises, and come into action automatically when he sits. Its bearings should be on the ischiatic tuberosity and

along the femoral shaft, the parts which commonly receive the corporal weight in the sitting position, as seen in Fig. 118. The head of a sitting figure is seen in Figs. 117, 118, and 119, at about its normal altitude, which is maintained without difficulty by a well man, whose weight falls on the ischium and on the shaft of the femur. But a patient who is shortened by disease can keep his head at this level only

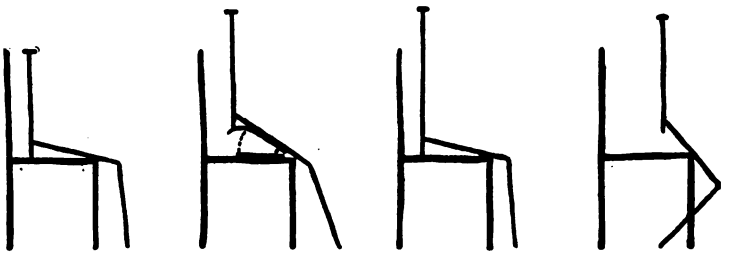


FIG. 116. FIG. 117. FIG. 118. FIG. 119.

FIGS. 116–119.—Proposed Device for Restoring Height in the Sitting Position (1898).

by supporting his body on the femoral shaft, at the cost of considerable effort in the constrained attitude seen in Fig. 119. When fatigue finally intervenes he will subside into the easy attitude seen in Fig. 116, in which the head is depressed as the result of his spinal shortening. In suitable cases this may perhaps be prevented by the apparatus suggested, but yet to be constructed.

Paraplegia.—An occasional and very troublesome complication of Pott's disease of the spine is para-

plegia, occurring early or late in the disease, accompanying disease of the upper rather than the lower regions, varying in severity from slight tremors to the inhibition of walking, having a gradual or sudden beginning with no recognizable immediate cause, produced not by pressure from a collection of matter or deformed bone, but rather by an extension of the inflammation to the membranes of the cord, sometimes of brief duration, but in some cases continuing a very long time, receding gradually or ceasing suddenly, recurring repeatedly in some cases, entirely irresponsive to treatment of any kind, but ceasing spontaneously in nearly every case, and supposed to be controlled indirectly to some extent by mechanical treatment of the deformity. The study of this form of paralysis led Mr. Pott to a knowledge of the morbid anatomy of the disease which bears his name.

Cervical Abscess.—Pott's disease is not often a fatal affection, but when it is seated in the upper regions of the spine the addition of an abscess introduces an element of danger. The vital conduits converging in a group at the base of the neck are in a peculiar position. Some of them transmit blood to and fro; others provide for communication between the brain and lower parts of the body, and others are ducts for the passage of air and nutritive ingesta. At this point they are collected and bound,

as in a sheaf, by muscular and fibrous structures and together they seek admission to the cavity of the chest through a gate formed by the body of the second dorsal vertebra, the clavicles, the manubrium, and the first and second ribs. An abscess arising in carious bone follows the direction of least resistance. It is usually harmless, but when it burrows from the cervical vertebræ downward in this narrow space it is a menace to life. It is not probable that a soft tumor of this kind can fatally occlude the trachea, whose firm walls render it practically incompressible except by severe external violence. But the windpipe may be flooded by a sudden purulent discharge into the pharynx, or fatal spasm of the glottis may be induced by interference with the pneumogastric nerve. It is not easy to determine the immediate cause of sudden death in cases of this kind, which give rise to reasonable anxiety and demand an early life-saving operation.

Psoas Abscess.—In another region a burrowing abscess may cause, not a fatal event, but serious deformity and disability. A slight contraction of a psoas muscle, indicating the migration of pus, and being perhaps the first sign of Pott's disease, may increase in extent and firmness until it leaves the patient crippled by flexion of the thigh, not unlike that following hip disease, differentiated from it by the presence of normal motion in every direction except

extension, and responsive to similar methods of treatment. The presence of a psoas abscess may be detected through the abdominal wall thoroughly relaxed by flexion of the thighs. In a thin patient the lumbar vertebræ and the promontory of the sacrum may readily be made out. Comparing the two sides deep exploratory palpation will show that the iliac fossæ are equally clear if matter is absent; but if an abscess is taking this route, the hand will be distinctly arrested in its descent into the iliac fossa of one side. In other regions the abscesses of Pott's disease are insignificant. They may be treated indirectly by giving strict attention to the welfare of the diseased bone in which they have their origin. As in disease of the hip or knee the result of a case of Pott's disease may not be affected by direct treatment of this complication.

CASE XVIII.—*Cold Abscess of Uncertain Origin.*—A girl, twelve years old, presented in May, 1902, a strange appearance caused by a fluctuating tumor of each natis. A third tumor, which simulated hernia so closely that a truss had been applied, occupied the left groin. Pressure on either tumor emptied it and increased the tension of the others. Pointing presently followed in the groin, and an eruption occurred in July without local symptoms or the appearance of blood. Collapse of the tumors followed a great discharge of the fluid common in cold ab-

scesses. Treatment was expectant, except that a plaster-of-Paris jacket was worn, unadvised, for several months. The sinus closed after flowing for ten months, leaving a scar attached to Poupart's ligament. The tumors were thought to have had their origin in disease of the lumbar or sacral vertebræ. General reaction caused anxiety for several months, but without much interference with the patient's activity and strength. The symptoms gradually and entirely disappeared during a vacation in the country. Other organs escaped disease, and in October, 1903, menstruation had been established and health was completely restored. The scar and a slight typical rotating lateral curvature were the only abnormal signs found in July, 1904.

Tuberculous action not very infrequently produces in the sternum an anterior deformity analogous to the posterior one of Pott's disease.

CASE XIX.—*Caries of the Sternum.*—In continuation of Case XIV. (pp. 178, 179): a fluctuating tumor appeared over the upper part of the sternum in December, 1880, the child being under treatment for disease of the left hip in the third stage. A month later it opened spontaneously with discharge of purulent semi-fluid. The sinus remained open for two years and ten months. Six years after it closed the resulting scar measured two inches by one inch and a half. It was superficial except at a depressed point

where it was attached to the manubrium. Caries at the junction of this bone with the gladiolus had left a marked deformity with a salient angle of one hundred and fifty degrees. The disease at this point was attended by no symptoms and required no special treatment. It pursued its course while the abscesses connected with the hip were alternating between eruption and quiescence. Their final closure followed that of the sternal sinus after an interval of five years. In 1895, five years after recovery from hip disease, the right kidney became affected and was operated on in July, 1897. After a considerable interval, in which the young woman was active and bore the appearance of perfect health, the remaining kidney was included and death soon followed in January, 1900. Her mother bore scars from early disease of the left ankle and tarsus. It would seem that there must have been some undetected reason for the tenacity of the tuberculous possession in this case, or for its return after it had surrendered its hold on the bony structures of the hip and thorax.

CHAPTER X.

LATERAL CURVATURE OF THE SPINE.

It is doubtful whether the physicians of antiquity recognized lateral curvature of the spine as a distinct affection. Cases in which the deformity was moderate they probably passed over as unimportant, and when rotation evolved a large kyphosis, as it does in rare instances, they may have resorted to the crude methods of forcible reduction which they applied, regardless of pathological conditions, to the deformity of Pott's disease. A knowledge of vertebral caries and spinal rotation was postponed to modern times. The latter adds a peculiar serpentine element to the appearance of a curving spine which could hardly have escaped the attention of early observers, although the first description of it seems to have been written by Dr. Dods in 1824. The manner of its production has been the subject of ingenious speculation and has caused many honest differences of opinion among medical men. The mechanics of this interesting puzzle seem to elude the understanding very much after the manner of a difficult proposition in algebra. For this reason probably the true explanation of this phenomenon failed

for a long time to receive general recognition. Many a page has been given to the discussion of the cause of rotation, which would have been unwritten if more weight had been given to the observation that when the column curves, one part of it fails to move laterally as promptly as another part. The tardy portion is the posterior section which, with its spinous and other processes, is incorporated in the posterior wall of the chest and abdomen. The freely moving part is the anterior section, where the vertebral bodies, with nothing on either side to interfere, are at liberty to move either to the right or to the left in a cavity occupied by unresisting viscera. The bisection of this great cavity into two deep sulci is evident in an autopsy. The projection into it of the spinal column is seen in Fig. 120. A hundred times a day, whenever the trunk bends for any reason, the column curves and the vertebral bodies swing over to one side or the other while the processes, being restrained, linger near the median plane. The result is rotation.

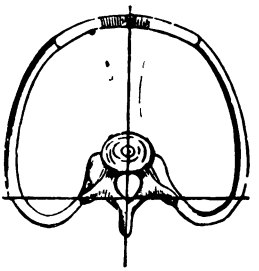


FIG. 120. — Horizontal Section of Trunk. (Alexander Shaw, 1842.)

A tragical illustration of this action of the spinal column occurred when President Garfield fell before the pistol of a lunatic. It is believed that the

noise of the first shot attracted the President's attention and caused him to look behind over his right shoulder. Hastening to avoid succeeding shots he strongly bent his body toward the left. This action threw the vertebral bodies far to the right where they received the second fire directly from behind. The direction of this fatal shot is represented by an arrow in Fig. 123. When the victim fell from concussion of the cord the straightening column gave an apparent deflection to the track of the ball. Many a wild animal, whose vertebral bodies are easily found by a shot, has unexpectedly gained its feet and escaped after a fall thus produced.

Hypothetical and Actual Vertebral Rotation.—Rotation, in general, may take place on a central, on a peripheral, or on a remote or foreign axis. This movement on a central axis is seen in the vertebra represented in Fig. 121. It is evidently not the rotation of lateral curvature. Rotation on a peripheral axis is performed by the vertebra seen in Fig. 122. This movement is exemplified in those cases in which the bodies describe a marked curve, while the spinous processes adhere in a straight line to the median plane. Aside from

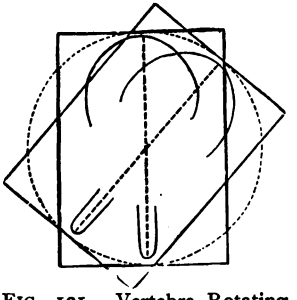


FIG. 121.—Vertebra Rotating on a Central Axis.

these exceptional cases vertebral rotation in lateral curvature takes place around a remote axis, as is

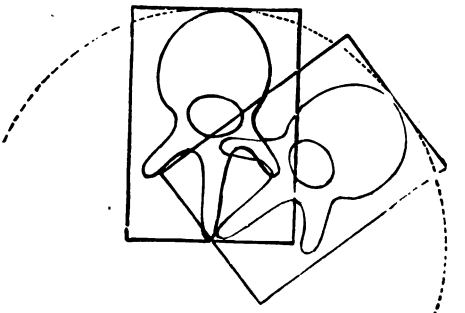


FIG. 122.—Vertebra Rotating on a Peripheral Axis.

shown in Fig. 123. This action gives to all sections of the vertebral column a participation in the curvature, which is greatest in the anterior section and

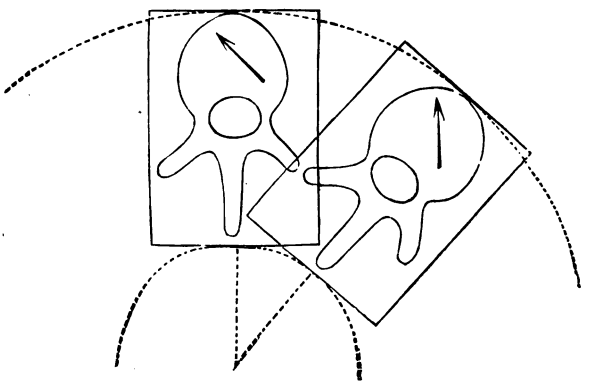


FIG. 123.—Vertebra Rotating on a Remote Axis (1876).

least in the posterior section, while the intermediate sections have more curvature as the anterior limit of

the bones is approached and less as their posterior limit is approached.

Rotating curvature is seen in the deportment un-

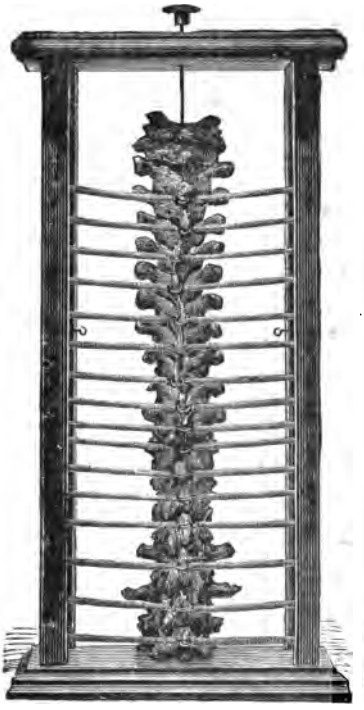


FIG. 124.—Spine without Curve or Rotation.

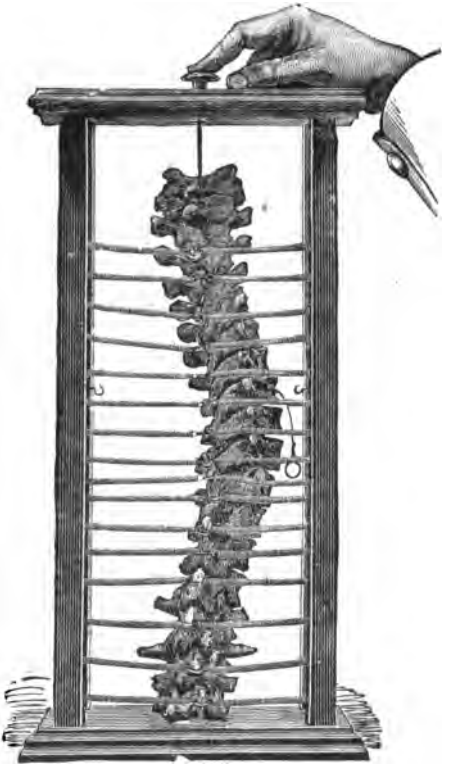


FIG. 125.—Rotating Curvature.

der pressure of the preparation seen in Figs. 124, 125, and 126. The bones are kept in line by a metallic rod which threads the round fenestra, made

from copper wire, which is seen in Fig. 127. The position of the rod is seen in Fig. 128. It is flattened in order to give it only lateral flexibility. A succession of spiral wire springs serves to keep the poste-



FIG. 126.—Double Rotating Curvature (1876).

rior section of the column near the median plane, just as it is restrained in the living body by being a part of the structures composing the posterior wall of

the cavity. When the column receives downward pressure it exhibits rotating curvature, seen in Fig. 125, and when the middle vertebra is restrained,

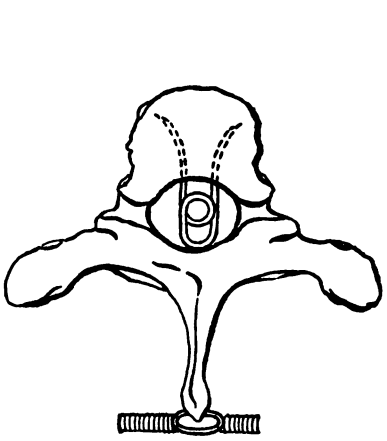


FIG. 127.

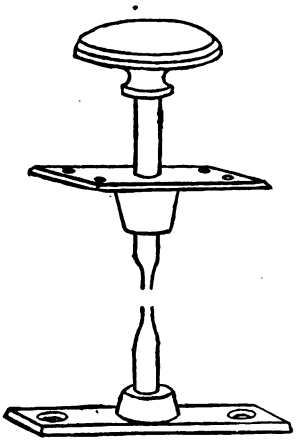


FIG. 128.

FIGS. 127, 128.—Isolated Parts of Preparation Seen in Fig. 124.

there is a compensating curve and a compensating rotation, seen in Fig. 126, as they occur in a healthy or in a diseased spine.

Rotation and Curvature Inseparable.—Rotation is not only a constant, but the most important, feature of the deformity from every point of view. It was formerly a question whether rotation or curvature was the primary deviation; but it is clear that they occur together, and that in the thoracic and abdominal regions the spine cannot curve without rotation. Exceptions to this are thought to occur in the de-

formity which follows collapse in certain serious affections of the lungs. It is also clear that the degree of rotation increases and decreases with the degree of curvature. In the upper dorsal region the slight beginning curve to the right is marked by a beginning rotation, in which the body of the vertebra is displaced farther toward the right than the processes. Lower down the curvature and the rotation increase with equal steps, and then, the extreme being passed, they decrease together till a neutral point is reached. Here there is no curvature. The vertebra at this point is in equilibrium in the median plane with rotation neither to the right nor to the left. Passing below the neutral point there is a curve to the left instead of to the right, marked by rotation opposite, of course, to that found above. Farther down still, the compensating curvature and the compensating rotation increase together in the lower dorsal and lumbar regions, and then they decrease till they disappear together in the lower lumbar and sacral vertebræ. The whole forms the sigmoid curve, to which rotation imparts a graceful and animating sinuosity.

The Internal Greater Than the External Curve.—As the anterior section of the column departs farther from the median plane than the posterior section, the full extent of the deviation is not indicated by the curve seen in the line of the spinous processes. If these show a marked curve, it is certain that the

bodies execute a still greater curve, unseen, in the cavity. Cases are not infrequently observed, exemplifying rotation on a peripheral axis, in which the processes show absolutely no deviation, while the curving of the bodies throws the ribs, the scapulæ, and the transverse processes into asymmetry. It is noteworthy that the **Effect of Rotation on the Torso** has been overlooked by ancient and modern sculptors of the nude figure. When the trunk bends laterally, rotating curvature of the spine brings into prominence unexpected masses of muscle, which would have given action where it is missing in the marble and bronze, although seen in the gymnasium. It is traceable in the bodies of leopards and such animals when they turn the corners of their narrow cages where it lends a subtle grace to their serpentine promenades.

DIAGNOSIS.

Misleading Tumors Caused by Rotation.—Rotation not only throws into relief unexpected masses of muscular fibres, but it also is responsible for a variety of mysterious tumors which stand ready to lead the most wary diagnostician astray. In the celebrated case of Dr. Gideon Mantell, whose spinal curvature was recognized only *post mortem*, rotation produced what seemed to be an abscess in the lumbar region, which Mr. Liston was prepared to open, with the

acquiescence of Mr. Brodie. Other consultants thought it was a lobulated tumor connected with the bodies of the vertebræ. As time passed, and as no change appeared in the tumor, it was suggested that "the matter was becoming firmer or concrete, and that the abscess was inclined to shrink, as abscesses sometimes do, and disappear." Cases are recorded in which aspiration had been tried in vain, and others in which evacuation had been advised and postponed. In the case of a patient who was presented to a medical society, a tumor was said by one observer to be cystic and by another an enlargement of the spine of the scapula. Another speaker said that on a previous occasion it had disappeared under an anæsthetic, leaving the inference that it was the result of muscular spasm. It was in fact a muscular mass brought into prominence by spinal rotation. Advancement of the left side of the chest gives to the mammary gland the appearance of hypertrophy, while a more accentuated prominence over the cardiac region simulates the deformity caused by an aneurysmal tumor. In Dr. Mantell's case the curvature was confirmed by changes in the shape of the bones, and the tumor was permanent. This is true in regard to some of the misleading tumors mentioned. Others of them, however, are transient, alternately appearing and vanishing with changes in the patient's attitude, which now produce curvature and

rotation, and again cause them to disappear. When the tumors caused by rotation affect this elusive quality they may be regarded as phantoms.

Recognition of Rotation.—It is important, therefore, to be able to eliminate the influence of rotation when considering certain tumors of doubtful origin. A useful diagnostic method may be practised by palpation of the chest between the palms, which may reveal a longer diagonal diameter in one direction than in the other, thus betraying rotation even in cases in which the spinous processes are in a straight line. When rotation makes prominent the angles of the ribs on the right side behind, the same movement brings out a prominence on the left side of the chest in front. An increase in the diagonal diameter in this (the first) direction is thus produced. At the same time, the same movement of rotation depresses the angles of the ribs on the left side behind, and also flattens the right side of the chest in front. A decrease of the diagonal diameter in this (the second) direction is thus caused. Since the same movement of rotation increases one diameter and decreases the other, a very moderate amount of rotation may, and often does, produce a difference in these diameters which is readily detected by bimanual compression of the chest applied diagonally, first in one direction and then in the other. With care the presence of a very slight rotation may be detected in this way.

Aside from occasional doubt as to the origin of some of the results of rotation, the recognition of lateral curvature is a simple matter. In the absence of symptoms and general reaction, diagnosis depends wholly on want of symmetry, which is first seen in the shoulders or hips, in many cases by a casual observer after an indefinite duration.



FIG. 129.—Right Sciatica Simulating Sacro-iliac Disease and Lateral Curvature (1885).

Sciatica.—Since it is customary in orthopædic work, and especially in lateral curvature, to lay more stress on signs than on symptoms, it is well to consider a peculiar spinal deviation accompanying sciatica. In this affection the subjective symptom of pain should overshadow all else, but it is accompanied by a deformity, or spinal deviation, remarkably suggestive of lateral curvature, with a distinct displacement of the axis of the chest forward and to the opposite side, as in Fig. 129. This patient, a professional man, forty-seven years of age, suffered severely from sciatica. When the photograph was taken he

had been disabled for eight months. Ten months later he unexpectedly recovered, after having received a great variety of advice and treatment in different parts of the country. Pain, disability, and spinal deformity were absent after his recovery, until he died of disease of the kidneys, after a short illness at the age of fifty-four. It is noteworthy that the displacement of the axis of the chest was always to the left, and never to the right, and that the patients were men, in a number of observed cases, as well as in the photographs in which a peculiar deviation is seen in the treatises of Sayre, Moore, Whitman, and others. The painful symptoms may extend to the toes, arresting passive extension of the knee when the hip is flexed, and flexion of the hip when the knee is extended. A spinal deviation having this origin may be useful as a diagnostic sign.

Sacro-iliac Disease.—It is important to note that the attitude of the patient in sciatica and his inability or disinclination to use the affected limb may lead to a mistaken diagnosis, not only of lateral curvature of the spine, but also of sacro-iliac disease. This affection is allied on one side with Pott's disease and on the other side with hip disease. It may receive neither the mechanical support which Pott's disease requires nor protection from the weight of the body by ischiatic support. A suitable mechanical environment for a tuberculous sacro-iliac joint is

to be found therefore only in recumbency. It is not easy to see why this disease is so rare when cases of the two affections with which it is allied are so common. An explanation may be hazarded as follows: When the case is mild, the stability of the affected bones and their relation of mutual support may lead to recovery before the disease is recognized; and when the case is severe, disability doubtless compels a resort to recumbency, which in time may lead to recovery before a positive diagnosis can be made. The recognition of this disease is exceptionally difficult on account of the deep situation and the immobility of the joint. It has been frequently said that the affection is likely to be complicated by abscesses, and that it has a generally unfavorable prognosis. Further knowledge is necessary before these statements may be accepted as beyond question.

Various Theories of Rotation.—Many explanations of the occurrence of rotation have been presented. It was formerly held that one of the functions of the articular processes was to prevent undue lateral excursions of the bodies of the vertebræ, and that pressure from a faulty position too long continued would change their shape and allow the bodies to rotate from the want of customary lateral opposition. Rotation was thus made to appear as the result of a morbid change in the vertebræ themselves, and not of influences derived from their relation to the wall

of the cavity. According to this view, if the left superior articular process of the ninth dorsal, for instance, yields to pressure and allows the left side of the eighth to advance, the same yielding would allow the left side of the ninth to recede, and there would be no disturbance either way, and of course no rotation; and as the inferior, as well as the superior, processes must yield to absorption from pressure, the ninth will rotate toward the left in obedience to the absorption of its superior process, and at the same time toward the right in response to the giving way of its inferior articulating process, and there would be no rotation in either direction. The cause of this movement may be sought, not in changes in the vertebræ themselves, but rather in a foreign agent, such as mural limitation of the mobility of the spinous processes. It has also been thought that the anterior part of the column has expansibility, and the posterior part compressibility, and that in curvature the expanding bodies seek the convexity where there is less pressure, leaving the compressed processes in the concavity where there is more pressure; but these spinal motions are so sharp and distinct that they could not be produced in this way.

At a meeting of the British Medical Association held in 1864, it was suggested that "the twisting is purely the mechanical consequence occasioned in the deviated or curved spine by bending it forward."

In criticism of this theory it may be recalled that the spine bent forward and at the same time laterally may not be said to have two curves, one antero-posterior, and the other lateral, but rather one curve



FIG. 130.



FIG. 131. FIG. 132. FIG. 133.

FIGS. 130–133.—Rotation not Affected by the Flexion or Extension of the Curved Spine (1901).

produced by the resultant of two forces, one acting antero-posteriorly and the other laterally. The curve thus produced is partly antero-posterior and partly lateral, but it is still a simple curve, and as such it

has no power to initiate a rotary movement. Fig. 130 represents an imitation of the vertebral column made of India rubber, in order to determine whether antero-posterior variations of the spine do or do not exert an influence on the production of the rotation which accompanies lateral curvature. The central pin is presented point blank to the camera in each exposure in order to secure the same point of view throughout the series. Fig. 131 shows a lateral curve without flexion or extension, Fig. 132 shows a lateral curve with flexion, and Fig. 133 shows a lateral curve with extension. Rotation does not appear in the series, except in Fig. 133. In this figure a careless arrangement of the object before the camera has given a quartering view of the central pin, which has resulted in what appears to be a slight rotation of the column. The effect of this mistake does not vitiate the demonstration that rotation is independent of flexion or extension. It simply calls attention to the necessity of holding the same point of view in the different members of such a series.

The True Theory of Rotation.—To find the cause of rotation the attention may be directed away from the column itself and its vertebræ. It has no intrinsic attributes inclining it to rotate, and no relation of some of its parts to others that can contribute to the production of this peculiar action. The cause of rotation is aptly explained by a reference to the ex-

trinsic agency of the chest wall, which imposes a restraint on a part of the spine without affecting other parts. This theory is in accord with all the conditions found. It explains the facts that rotation attends the transient curves of health and the confirmed curvature of disease, that it is absent in the cervical region, and that it crosses the median plane in company with the compensating curve. The observation made in 1876 that rotation was produced in this way was thought to be new, but Mr. Noble Smith, in 1882, referred to the work of Mr. Rogers-Harrison, who made the same observation in 1842. It is so simple, when it is apprehended, and such a complete and satisfactory interpretation of a common clinical incident that it has probably occurred to others, and very likely may be found in writings before the time of Mr. Rogers-Harrison.

Incidental Rotating Curvature, when it occurs as the result of an habitual one-sided attitude or carriage of the body, may be sufficiently arrested by timely correction of the bad habit. It is assumed in an unconscious effort to maintain equilibrium menaced by the loss of an arm or the collapse of a lung. It accompanies shortening of a leg by accident or disease, and may then be lessened or removed by factitious lengthening of the short limb, as in Figs. 108 and 109 (p. 181), where compensation is made by a book placed under the foot.

Typical Lateral Curvature.—The greater number of cases, however, occur without any known cause, except such as may be found in muscular inability to sustain the impending weight, which overcomes the spine and causes it to sag more and more till it presents an instance of typical lateral curvature. The etiology of this affection remains obscure, and its treatment is still so unsatisfactory that when the deformity is confirmed by changes in the bones it is generally believed to be beyond the reach of any attempts at reduction. It is fortunate, therefore, that the affection does not compromise longevity or interfere with a life of industry and activity. It might be argued, but not too seriously, that a lateral curvature is an agreeable departure from conventional symmetry, an attractive feature, to be placed in the same category with a slight cast, or squint, which has been thought to add piquancy to a regular face. It may not be denied that it repeats the curved line of beauty, or that rotation carries an expression of serpentine grace.

TREATMENT.

Although it may not be possible to make an established curvature disappear, careful treatment may be expected partly to reduce the deformity or to render it less noticeable. Especially should treatment be thorough when a case shows any indication

of assuming a rare form in which the angles of the ribs are pushed backward by rotation until the resulting kyphosis rivals that of a neglected case of Pott's disease. It may not be concluded because the deformity of lateral curvature is not as a rule offensive, or attended with disability and danger to life, that the treatment of this affection is to be lightly considered. The possibility of an excessive protrusion of the angles of the ribs should be in the mind, to encourage earnest and careful treatment. When one of these rare cases is fully developed, an extensive and very prominent kyphosis, quite near the middle line of the back, has its profile made up by a succession of accentuated angles of rotated ribs, and not, as in Pott's disease, by the projection of the spinous processes of carious vertebræ. The deformed and deflected processes may, with care, be isolated and counted near the crest of the costal kyphosis and almost overhung by it. The stature is reduced by a descent of the thorax and its lodgment on the pelvic bones, as in Pott's disease. This condition is serious enough to call for every resource of watchfulness, prevention, and treatment.

The wish is often expressed that apparatus could be so made that it would do, with certain plastic deformities, what can be done so easily by the hands. It would seem that rotation could be diminished, temporarily at least, by rolling the chest forcibly

between the palms, but it is at present beyond the power of mechanical therapeutics to produce and prolong this effect, and especially to oppose simultaneously the primary and the secondary deviations. If, however, either curve could be reduced in this way, compensation would bring the whole column into a straight line.

Antero-Posterior Pressure.—For many years the opinion, which received the early advocacy of Dr. Lee, has been under consideration that antero-posterior pressure, long continued and forcible, would be curative in lateral curvature, as it is in Pott's disease, by transferring the pressure of superincumbent weight from the anterior to the posterior section of the column. There is a suggestive analogy in the relations of the vertebræ in the two affections. In Pott's disease the anterior part of the bone is carious, and a brace transfers pressure to its posterior part, which is unaffected. In lateral curvature the anterior portion departs from the median plane, and a brace might transfer pressure to the posterior portion, which adheres to the median plane. Furthermore, pressure applied directly from behind would meet the transverse processes of the convex side which are rotated backward, before it could reach those of the concave side, which are rotated forward. It would therefore directly and positively oppose rotation. The plan is certainly attractive from a me-

chanical point of view. When a trial of it was made in 1876 and 1877 it was found to be easily practicable. It was difficult, however, to continue the treatment long enough to note whether it could be relied on to produce positively favorable results. The method would be justified and commendable if the pathology and prognosis of this affection were as serious as those of Pott's disease. This plan may be compared and contrasted with the common method of making lateral pressure on the projecting ribs, which is open to the objection that although such pressure is to all appearances reasonably applied to reduce an obvious projection, it is applied to the ribs, which show an incidental deformity, and not to the curving spine, which is the seat and origin of the trouble. A review of the anatomy of the part recalls the fact that the ribs are attached to the spine so near to its posterior and so far from its anterior section that pressure on them, applied with any degree of force, would increase rotation or at least prevent its reduction. If pressure could be made by invading the cavity (which is as yet impossible), and pushing laterally and forcibly against the bodies of the vertebræ, it is conceivable that both curvature and rotation could be opposed by one motion.

Treatment Based on Clinical Observations.—It seems proper, therefore, to decline to make the application of a brace the rule of practice, subject of course to

the proverbial exceptions which are said to prove a rule. But something should be undertaken not to reduce the curvature entirely, which is very seldom done, but to modify it and its incidental deformities and to prevent an increase of the trouble.

Recumbency.—In the course of clinical observations it is evident, at the first examination, that the curvature is diminished when the weight of the upper part of the body is removed by recumbency in the prone position. Rotation and its incidental deformities also largely disappear with the curvature. But these phenomena return in full force when the patient rises. These changes doubtless take place unseen when standing alternates with the supine position, which hides the back from view. It follows that a growing child, affected with lateral curvature, should be led to occupy the recumbent position as much of the time as possible, so that the increment incidental to natural growth may be correctly placed and favor symmetry. "Just as the twig is bent, the tree's inclined."

The question has been debated whether this affection could occur in a child whose attitude from birth had been absolute and uninterrupted recumbency. If downward pressure by the weight of the upper part of the body were the only direct cause, there could of course be no lateral curvature in a child who had never been placed in the erect position. But

muscular contraction is also to be counted as one of the direct causes. It may be recalled that the muscles of the trunk assume a general tonic condition when any considerable movement is made elsewhere, in order to afford a firm base of action for motions of the head or in the extremities. Probably very few movements take place in any part of the body without a longitudinal compression of the spine. This would favor the production of lateral curvature as certainly as compression made by the weight of the head and upper part of the body.

Muscular contraction has, however, a limited effect in this direction, and superincumbent weight must still be considered as the principal direct cause of lateral curvature. Recumbency, practised several hours daily, is therefore to be retained as an important part of systematic treatment. In the supine position an air pillow, inflated to an increasing degree as the patient becomes accustomed to its use, should occupy such a position under the back as to maintain lordosis. This may be considered as an imitation of the effect of the proposed antero-posterior brace, the action of which transfers pressure from the more affected to the less affected section of the spine. This position should be maintained during sleep so far as is practicable. An air pillow of convenient size is "No. 2," which measures about eighteen inches by ten inches.

Suspension.—Observations being resumed, it is seen that the curvature disappears even more promptly and completely when the patient suspends herself from an overhead bar than when she lies down, and that when the hands relinquish the bar there is a sudden return of the curvature and all of its incidental deformities. Suspension should therefore be added to the list of important therapeutic agents. There should be no muscular effort beyond that required to keep the fingers flexed on the bar. The body may swing gently in suspension, as a means of timing the exercise, seven vibrations backward and forward measuring one-quarter of a minute, which is long enough for each effort at the beginning. A simple doorway bar may be conveniently used for a number of exercises, half a dozen or so, with suitable intervals, on rising in the morning. More time and effort may be expended at bedtime, to be followed by the night's rest. In the routine of the day the bar should be in use as much as is practicable. The customary apparatus for suspension by the head and the axillæ will give facility and thoroughness to these exercises.

Chest Expansion.—It will be observed that the chest is expanded during suspension. The sternal ends of the ribs being attached to the bar through the intervention of the arm, forearm, and hand, their vertebral ends are drawn downward by the weight of

the body and lower limbs, producing forced inspiration in a very positive manner. The effect of deepening and facilitating inspiration by the practice of suspension has received well-merited attention. Dr. Henry G. Davis made it a part of a method by which he believed that he had demonstrated the curability of phthisis pulmonalis. The physiological and mechanical considerations which give to suspension its value as a means of developing the chest are illustrated in Sylvester's method of resuscitating those about to perish by asphyxiation. It may also be recalled that audible suspiration is made when the conditions are favorable by a cadaver drawn up and laid supine on the floor of the dissecting-room, after transit from below while suspended by the arms. It is said that patients seek relief in asthmatic paroxysms by grasping the top of a door in the absence of a more convenient support. Dr. French, of Portland, Maine, in 1877 introduced a respiratory brace, shown in



FIG. 134.—Respiratory Brace for Orthopnœa. (Dr. French, 1877.)

Fig. 134, for the relief of orthopnœa. With this device in use suspension may be conveniently graduated in severity as the patient is seated and can at will put more or less of his weight on the supporting straps. Suspension applied as a part of the treatment of lateral curvature, coinciding, as it will, with the period of growth, may reasonably be expected to produce a lasting effect on the size of the thorax and capacity of the lungs. This accession of respiratory ability cannot but react favorably on the general health and especially on the muscular system, whose failure is apparently a link in the chain of causes of lateral curvature. A further consideration of this form of exercise will also show that it provides what has been most diligently sought, a **Method of Directly Opposing Rotation,** an element of the deformity which lateral pressure from without is unable to affect, except adversely. Suspension opposes rotation from within by overfilling or inflating, by a forced development of its contents, the cavity upon which rotation encroaches.

Rest.—Observations being resumed, it will be seen sooner or later that fatigue or weakness increases the appearance of deformity. During an indisposition, or after a long walk or wearisome journey, more than the customary degree of curvature is noticed, while if the patient is not tired and is sustained by good sleep and digestion, the general well-being finds ex-

pression not only in the face but also in less curvature and rotation. From this observation may be derived the practical suggestion that throughout the growing period overexertion should be avoided. The child should not be told to "sit up straight," but to lie down. Moderation should govern the daily routine, the pastimes, and all the duties, mental and physical, of child life at home and at school.

Sequence of Causes of Rotating Curvature.—From this review of clinical phenomena a probable sequence of the causes of rotating curvature may be formulated in these words: The diminution of the cavity of the chest is caused by the rotation; the rotation in caused: (1) by an unequal lateral displacement of the anterior and posterior sections of the spinal column; and (2) by the curvature; the curvature is caused by a failure of the muscles to hold the column erect under its natural burden; the failure of muscular action is caused by defective innervation, the cause of which is as yet conjectural.

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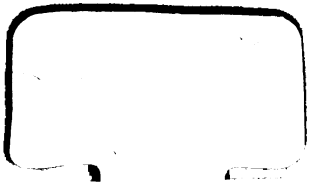
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